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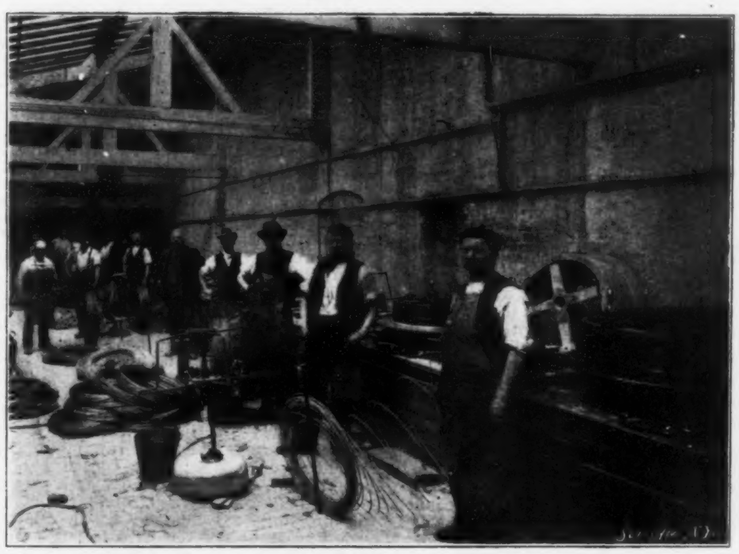
METAL ROLLING-MILL. IN THIS MILL THE BRASS WIRE BARS ARE ROLLED READY FOR THE WIRE-MILLS.

BRASS AND COPPER WIRE MILLS. WHERE THE BRASS WIRE IS DRAWN TO THE VARIOUS SIZES REQUIRED.

IRON AND STEEL ANNEALING PLANT AND CLEANING SHOPS. WHERE THE WIRE IS SOFTENED AND CLEANED BEFORE IT GOES TO THE DRAWING-MILL.



IRON AND STEEL DRAWING MILL. WHERE THE WIRE IS DRAWN TO THE SIZES REQUIRED FOR THE MANUFACTURE OF STEEL PINS.

A BIRMINGHAM MILL IN WHICH TWELVE MILLION PINS ARE MADE EVERY DAY.

THE MANUFACTURE OF PINS.

THE MAKING OF PINS.*

THE origin of the common pin, like that of most household articles, is exceedingly nebulous, for the pin has an ancestry as old as the oldest. In some form or other our forbears were familiar with this most useful of all devices. No doubt the pattern for the pin is to be found in the thorn. Indeed, the first pin no doubt was a thorn. Excavations of the old ruins of Egypt and Scandinavia, as well as of the sites of the ancient lake dwellings of central Europe, have brought to light pins made of copper, iron, bronze, ivory, bone and wood. In central Europe alone some ten thousand pins have been discovered of various forms. These ancient pins differed much in shape from the modern article; they tapered gradually from the head to the point and were, moreover, somewhat longer. Among the more curious types are those found in Central Europe, provided with double stems like the modern hairpin. In Italy, the predecessor of the modern safety-pin has been found. Of the single-stemmed pins, many varied in thickness; some even had heads formed of a loose ring fitted in an eye at the blunt end.

Since the metal most commonly worked by the artisans of ancient times was bronze, it is but natural that many of the pins which have been found in ancient ruins were made of that metal. Although the ancients were more or less familiar with brass, yet the invention of the brass wire pin must be credited to the French. On this point, however, there is some doubt; for the Dutch claim the honor, and not without reason. In England pins of iron wire were made during the fifteenth century. Catherine Howard introduced the brass pin from France in 1543.

The modern manufacturing process of pin-making may be said to have begun with the invention of a process for drawing wire. The process in question had its origin in France and Germany, which countries for two hundred years had a complete monopoly of the industry. John Tilsby, who in 1621 established a plant in Gloucestershire, was the first to manufacture brass pins in England. His success was noteworthy; and his pins made him famous. A decade had hardly passed when the industry was so deeply rooted that a corporation or guild was formed in London by the pin-makers. Finally, the industry spread outward and lodged in Bristol and Birmingham, where it became localized. For many years pins were made in the Birmingham and Bristol factories by hand. That the manufacturing process was arduous can readily be understood. A single pin required from fourteen to eighteen operators, and involved many processes. First the wire had to be straightened and cut. Then came the cutting, printing and twisting of the heads. The heads were again cut, and thereupon annealed. After these processes the heads were stamped into shape. The whole pin was then cleaned, which process was followed by whitening or tinning. After being washed, dried and polished, the pins were collected in papers which had previously been winnowed and pricked. Timothy Harris in 1791 improved upon this complex method by laying the blanks of the solid-headed brass into a two-part mold, in which prints representing the heads were cut. An alloy of lead and antimony was poured into the mold. When the pins were released, and the "gets" cut, the pins were cleansed by immersion in a solution of sulphuric acid and water. They were then dipped into a solution of sulphate of copper and finished much as other brass pins were.

Timothy Harris' process was further improved upon by William Bundy, who may, indeed, be said to have been the first to begin the manufacture of pins in accordance with modern ideas. Bundy pressed the wire into a collar on which the head rested to prevent its slipping down. Then the head was placed on a shank in a die. Another die, working in a fly-press, dropped and pressed the top of the wires, thus attaching the wire head to the shank.

The idea of making pins automatically originated with Bradbury and Weaver, in 1812. The shanks were first pointed and the heads tapered. The shanks and the heads were then put into separate hoppers, where the shank and head were mechanically placed into relation with each other. The parts of the pin, while held in this position, were pressed by screws against dies which formed the head and united it to the shank. The pins were then withdrawn by hooks operated upon by parallels and worked by the machine.

Seth Hunt in 1817 invented a machine to make pins with the head, shank and point from one piece. His invention, however, was not a success. Seven years later W. L. Wright, an American, invented the solid-headed pin-making machine which, to use a much-abused term, "revolutionized" the manufacture of pins. Wright took out no patents in America. He set up his machine in England and there put it into operation. So promising did his machine seem, that he succeeded in forming a company in London and building a factory in Lambeth. Although the plant was fitted up at great expense and equipped with about sixty machines, it proved unsuccessful; for the machines failed to point the pins. Subsequently, Mr. Wright remedied this defect; but the company still did not succeed, and suspended operations after having lost no little money. In the readjustment of the company's affairs, the machinery fell into the hands of D. F. Tayler, who brought about the formation of the company known as D. F. Tayler and Company, which, in 1833, put upon the market the first machine that made solid headed pins sold anywhere in the world. So successful was the company that its machine-made pins soon supplanted the hand-made pins made in England. The views which we present herewith were taken in the Birmingham factory of D. F. Tayler and Company.

In America the attempts to make pins by machinery have been both numerous and unsuccessful. These attempts were chiefly made at times when commerce with England, France and Germany was interrupted. During the Revolution, when the importation of pins from England was altogether cut off, the manufacturing process was carried on in a half-hearted way in Connecticut, and the Carolinas. When the war of 1812 broke out, importations were again suspended. Pins became so scarce that they were often sold at prices ranging as high as a dollar a package. A few pin-makers came over from England about this time, bringing with them the necessary tools. They began making pins at the old State Prison at Greenwich, N. Y., employing convict labor. After the close of the war, the price of pins rapidly declined and with it the success of the enterprise. The tools used by the Englishmen passed into the hands of Richard Turnam, who employed paupers and converted the almshouse at Bellevue, N. Y., into a pin factory. Turnam's death brought this enterprise also to an end. Thereafter the English tools were never again used.

The first American pin-making machine was brought out by Moses L. Morse, of Boston, some time during the war of 1812. Since it proved much too delicate and much too intricate for practical purposes, it was abandoned.

Dr. J. I. Howe probably did more than any other American to place upon a firm footing the manufacture of pins in the United States. After he had carefully studied the industry in Europe, he began work here. In 1832 he had taken out patents in this country, France and England, on a machine designed to make pins similar to the English diamond pins, with heads formed of coiled wire fastened upon the shank by pressure between the dies. His enterprise thrived to such an extent that it now forms one of the principal industries of Birmingham, Conn. Howe's first efforts were directed to the making of spun-head pins. In 1840, however, he had equipped his plant with solid-head machines, each capable of making from forty to fifty pins a minute. Later the machines were so far improved that they could turn out as many as from sixty to seventy per minute.

Still another American inventor whose name should be mentioned in connection with the development of the pin industry in this country is Samuel Slocum. In 1835 or thereabout, Slocum took out a patent in England for a machine by which solid-headed pins could be made. Three years later he began the making of pins in Poughkeepsie, N. Y. Not having taken the precaution to protect his invention by letters patent, he was compelled to carry on his manufacturing process in secret.

The peculiar tariff system in vogue until 1842 had crippled the pin industry in America. With the new tariff law of 1842, however, by which the industry was very considerably favored, the pin-makers of America entered upon a career of prosperity. Indeed, so profitable was the business that innumerable machines were invented for the construction of pins. Overproduction followed, with the result that all but the two old companies at Poughkeepsie and at Birmingham collapsed. Other companies, however, soon entered the field again, and the industry once more revived. The improvements which about 1850 were made in pin-making machinery by Fowler and Atwood, were noteworthy. The machines which they devised were capable of turning out as many as 160 to 170 pins a minute. Naturally they all but displaced the earlier machines.

With the problem of providing a machine that would successfully make pins automatically, manufacturers now turned their attention to the invention of a machine which would stick them in paper. Both Howe and Slocum had pondered over this matter as early as 1840. Howe had invented a device for crimping the paper. Slocum had devised a distributer. These two inventions were combined, and effected a great increase in the number of pins that could be stuck on paper in a day. The "gooseneck" or "runway," invented by De Grasse Fowler, did much to improve these devices. The sticking machines in use for many years may be regarded as a combination of the Howe, Slocum and Fowler inventions. More recently, however, machines have been introduced which will stick from 500 to 600 packages a day, many times as many as the earlier machines.

The modern process of pin manufacture may be described briefly by a recitation of the process through which the raw material must pass before the finished product is turned out. Wire is drawn from a reel automatically by a pair of pincers, between fixed studs which straighten the wire. A pin length is then gripped by a pair of lateral jaws, from which a portion of the wire is left projecting. A snap-head die then advances and partially shapes the head. The blank is now released and pushed forward about a twentieth of an inch. The head is then given another squeeze by the same die. By this repetition of motion the head is completed, and the blank is cut off the wire in the length desired. About an eighth of an inch of the wire is necessary to make a pin head.

The headed blanks are dropped into a receptacle in which they arrange themselves in the line of a slot formed by two inclined and bevel-edged bars. Since the opening between the bars is just large enough to permit the shank to fall through, the pins are suspended in a row along the slot. When the blanks reach the lower end of the inclined bar in their suspended position, they are seized between two parts of the machine and passed along, rotating as they move in front of a cylindrical cutter, with sharp grooves on its surface, whereby the pins are pointed. Thus properly shaped, the pins are thrown from the machine. If they be brass, they are cleaned by being boiled in weak, sour beer. After they have been cleaned, they are tinned. This process is effected by placing alternate layers of pins and grain tin in a copper can to which a weak solution of bitartrate of potash is added. The can is heated, and a solution of tin is produced which is deposited on the surface of the pins. The pins are removed and brightened by being shaken in a revolving barrel of bran or sawdust. Now comes the final operation of "papering." The pins to be stuck are placed in a hopper in connection with which a steel plate is used, with longitudinal slits corresponding with the number of pins which form a row in the paper. The pins in the hopper are stirred up by a comb-like tool; the shanks drop through the slits in the steel plate, and the pins are suspended by their heads. Long, narrow sheets of paper are presented by the operator to the action of a machine, by which two raised holes are crimped. The row of pins collected in the steel plate is then pressed through two crimped folds by the same action. These operations are repeated until the requisite rows of pins are stuck in each paper.

In the United States the manufacture of pins has become such an industry that the mills of this country do much to supply the world's demand. In 1900 the 75,000,000 people in the United States used 66,000,000 gross of common pins, which is equal to 9,500,000,000 pins, or an average of about 123 pins for every man, woman and child in the country. This is the highest average reached anywhere in the use of pins. Ten years ago we used only about 72 pins each.

The total number of pins manufactured in the United States during 1900, the census year, was 68,889,260 gross. There are forty-three factories in all, with 2,353 employes. The business has grown rapidly during the last twenty years, for although there were forty factories in 1880 they produced only half as much, employed only about half the capital and only 1,077 hands. There has been a considerable increase in the number of women and children employed in pin factories of late years, which is an indication that the machinery is being improved and simplified and that its operation does not require so high an order of mechanical skill.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

[Continued from SUPPLEMENT No. 1412, page 22637.]

MODERN TENDENCIES IN THE UTILIZATION OF POWER.*

By JOHN JOSEPH FLATHER.

MENTION has been made of the use of hydraulic motors as a factor in the subdivision of power, but these are being used to such a limited extent for this purpose that we shall not consider them at the present time.

There is, however, a growing field of usefulness for hydraulic power in manufacturing operations which is peculiar to this agent alone, namely, its use in forging and similar work. Where hydraulic power exists for this purpose it is also generally used for a variety of purposes which could be accomplished just as well, and often more economically, by steam or compressed air; but in forging operations where heavy pressures are required hydraulic power is infinitely better than either.

The compressibility of air is an objection in many lines of work, and it is now well recognized that the effect of a hammer blow is oftentimes merely local. As Mr. H. F. J. Porter has so ably shown elsewhere,† the pressure applied in forging a body of iron or steel should be sufficient in amount and of such a character as to penetrate to the center and cause flowing throughout the mass; as this flowing of the metal requires a certain amount of time the pressure should be maintained for a corresponding period.

Hydraulic pressure, instead of a hammer, should, therefore, be used to work it into shape. Under its action the forging is slowly acted upon and the pressure is distributed evenly throughout the mass, whereas under the high velocity of impact of the hammer the metal does not have time to flow, and thus internal strains are set up in the mass, which may cause serious results, especially with certain steels which have not the property of welding.

Besides the fundamental defects incident to the method, it is very troublesome to use a hammer in certain lines of work, on account of mechanical difficulties of manipulation.

The quality of the steel is very much improved by the processes of hydraulic forging, and we find a marked tendency to substitute this method in a wide variety of work in which presses are employed varying in capacity from 20 tons to 14,000 tons.

We are all familiar with the fact that the magnificent 125-ton hammer made by the Bethlehem Steel Co. lies idle, while the work for which it was intended is done by a 14,000-ton hydraulic press operated by an engine of 15,000 horse power; it may not be so generally known, however, that all forgings except small pieces are done on hydraulic presses, and that the largest hammer in actual operation is one of 6 tons capacity in the blacksmith shop.

The pressure used in these works is 7,000 pounds per square inch, but the present tendency indicates the use of a so-called low-pressure transmission service under a pressure of 400 or 500 pounds, with an intensifier at the press which raises the pressure to 2,500, 5,000, 7,000 pounds, or whatever may be required.

In this case the lifting and lowering of the ram of the press is effected by low-pressure water, so that the cylinder always remains filled, and the high pressure is only brought to bear the moment the dies come in contact with the pieces to be forged. The intensifier is built in multiple, which permits of a variable force to suit the work to be done; its action and control are extremely simple, and results are produced which show a marked increase in speed and a decided economy in operation. Some of the recent German hydraulic forging machines equipped with intensifier operate at a speed of forty to seventy strokes per minute, on finishing, and twenty to thirty strokes per minute for the heaviest work.

The success which has attended the use of hydraulic power in forging is causing it to be applied to other and similar work to an increasing extent. In boiler works, railroad and locomotive shops, bridge works, and ship-yards it is used along with compressed air, but where heavy pressures are desired hydraulic power is greatly to be preferred; hence we find it operating machines for punching and shearing heavy plates and sectional beams, riveting machines, stationary and portable, flanging and bending machines, tube upsetting machines, wheel and crank-pin presses, lifting jacks, and hoists of all kinds.

For heavy boiler work hydraulic riveting seems well adapted, as an intensity of pressure can be brought to bear upon the plates which is obtained by no other method.

We have already stated that compressed air as now used without reheating is not at all efficient as a source of motive power since the combined efficiency of compressor and motor, even under favorable conditions, is not more than 50 per cent of the available energy put into the compressor. In other cases the efficiency is as low as 20 per cent.

* Address of the chairman of Section D, Engineering and Mechanical Science, and vice-president of the American Association for the Advancement of Science. Read at the Washington meeting, December 29, 1902.

† Trans. A. S. M. E., Vol. XVII.

In the transmission of air, within reasonable limits, the loss in transmission if the pipes be tight need not be considered, for although there is a slight loss in pressure due to the frictional resistances of the pipes, yet there is a corresponding increase in volume due to drop in pressure, so that the loss is practically inappreciable.

There should be no comparison between the cost of power by compressed air and its brilliant rival, electricity, since each has its own field of usefulness, yet it may be interesting to note for our present purposes the efficiency of electric power. A modern shop generator belted from an engine will have an efficiency of about 90 per cent when working under favorable conditions, but as the average load is ordinarily not more than two thirds full load, and often much less, the efficiency will not usually be more than 85 per cent. Since the engine friction was added to the losses in compression, so also it should be considered here, in which case the efficiency of generation will lie between 75 and 80 per cent. With a three-wire 220-volt system, which is very suitable for ordinary shop transmission when both light and power are to be taken off the same dynamo, the loss in transmission need not be more than 5 per cent, so that the efficiency at the motor terminals will not be far from 75 per cent. With motors running under a nearly constant full load the efficiency of motor may be 90 per cent; but with fluctuating loads this may fall to 60 per cent at quarter load. In numerous tests made by the speaker the average load on several motors in machine shops has been only about one-third of the rated capacity of the motor. It is interesting to note that in tests made at the Baldwin Locomotive Works it was found that with a total motor capacity aggregating 200 horse power, a generator of only 75 kilowatts was sufficient to furnish the current, and ordinarily only 60 kilowatts, or 40 per cent, was required. At the present time there are in use at these works upward of 300 motors, with a combined total capacity of 2,200 or 2,300 horse power; whereas the generator output is only about 500 kilowatts.

Under those conditions, where the driven machines are not greatly over-motored, we may assume a motor efficiency of 80 per cent, which may be less or greater in individual cases. The combined efficiency, then, of generator and motor working intermittently with fluctuating loads will be about 60 per cent of the power delivered to the engine.

For greater distances than those which obtain in plants of this character the loss in transmission will be greater, and higher voltage must be employed in order to keep down the line loss. While it is possible to put in conductors sufficiently large to carry the current with any assumed loss, yet the cost of the line becomes prohibitive with low voltage.

Where cheap fuel is available it is found in most cases that electric power can be generated at the works more cheaply than it can be purchased from a central station; especially is this the case if the exhaust steam be used for heating purposes. In isolated plants the cost of transmission is very small as compared with the total cost of generation; whereas in the average central station the cost of transmission, which includes interest and depreciation on pole line, usually constitutes a large percentage of the operating cost.

In those localities where the cost of fuel is high, electric power can often be purchased more cheaply from a central station which obtains its power many miles distant and transmits it electrically to a convenient distributing center, where it is used for power and light.

The recent development in electrical transmission is very marked, and one constantly hears of some new achievement more wonderful than anything previously accomplished. Distances have been gradually increased until it is now possible to transmit electrical energy economically and in commercial quantities up to 150 and even 200 miles.

There has been a steadily increasing tendency to raise the line voltage in such transmissions, and to-day we find in successful operation voltages as high as 40,000 and even 60,000 as compared with the 4,000 and 6,000 volts of a few years ago.

As pointed out by Mr. A. D. Adams,* so far as present practice is concerned the limit of use of high voltages must be sought beyond the transformers and outside of generating and receiving stations. As now constructed, the line is that part of the system where a final limit to the use of higher voltages will first be reached.

In order to avoid the temporary arcing and leakage between the several wires it is necessary to place the wires a considerable distance apart, which, with higher voltages, may lead to a modification in construction of pole line. The plan of substituting a series of steel towers about 90 feet in height and 1,000 feet apart is being seriously contemplated.†

In this case it is proposed to suspend the wire from tower to tower and separate them about nine feet apart. While expensive in first cost, it is thought that the satisfactory working of the system and freedom from breakdown, with the low maintenance and depreciation charges involved, would warrant the investment.

A more serious difficulty is found in the insulator, which is generally looked upon with distrust for the higher voltages in use to-day. With a more perfect insulator there would appear to be no good reason why the present maximum voltages should not be exceeded.

The possibility of electrical transmission thus permits of the utilization of available sources of power at great distances from the center of distribution; but while it is interesting to know that a certain amount of power may be transmitted a given distance with a high degree of efficiency, it is more important to know whether the same amount of power could be obtained at the objective point more economically by other means.

It has been suggested that the future of long-distance transmission depends largely upon the development of oil as a fuel; but at the present time the outlook for oil fuel in general competition with coal or long-distance transmission is not encouraging; while the development of the Texas and Southern California oil fields has increased the visible supply and brought about increased activity in the use of liquid fuel, yet it is doubtful whether the advantages would be sufficient to cause it to come into general use as a fuel, since with a limited production and an increased demand for this and other purposes the cost would be correspondingly increased.

A number of railroads contiguous to the oil-producing centers have equipped their locomotives to burn this fuel, and it is used to some extent to fire marine boilers, and with great satisfaction; since its displacement for a given heating value is only about one-half that of coal, and the labor cost is materially reduced.

It is also used quite extensively in certain sections of the country as a steam producer in power plants, but it is hardly probable that liquid fuel will be a serious competitor of coal, notwithstanding its many advantages. At the present time, as far as power for manufacturing plants is concerned, it is largely a question of transportation, whether oil can be laid down and handled at a given point more cheaply than coal. It is probable, however, that oil fuel will supply a local demand in certain sections where transportation charges, and possibly insurance, will permit its use at a low cost, and it is in this connection that it may become a competitor of electrical transmission.

One interesting phase of the power problem which forcibly presents itself to the engineer at the present time is the vast possibilities possessed by the modern combustion engine, which includes the various types of gas and oil engines. While its use as a motor in industrial establishments has been somewhat limited, yet there is a marked tendency to employ the gas engine in manufacturing works, and a consideration of its advantages and cost of operation, together with its high thermal efficiency and possibility of still further improvement, indicates that, for a great many purposes, both steam engines and electric motors may be ultimately replaced by gas engines.

While the first cost of electric motors in the smaller sizes is considerably less than the cost of well-made gas engines for similar capacities, the saving during the first six months of service, due to the more economical operation of the gas engine, will often more than compensate for the difference in first cost.

That the gas engine in both large and small sizes has reached a point in its development where it can fairly rival the steam engine in reliability and satisfactory running qualities there can be no question. In point of fuel economy, a gas engine of moderate size is on a parity with the largest triple-expansion steam engines, and will give a horse power on less than one pound of fuel.

The high price of gas in this country has contributed largely to those causes which have prevented a more common use of the gas engine as a motor. For this reason the gas engine has generally been used, not so much because of its high efficiency as a thermodynamic machine, but rather on account of its convenience and saving in labor. It is true that natural gas is cheap, but it is equally true that natural gas is not generally available.

It is to producer gas that we must look for any marked increase in the use of the gas engine. Fortunately the manufacture of producer gas has reached a high state of development, and there are now in successful use several processes by which power gas can be made from cheap bituminous coals as well as anthracite and coke. The leanness of such gases renders them less effective per cubic foot of gas, as compared with the richer coal gas or even water gas; but this difference is more than compensated for by the low cost of production. It is upon such power gas that the commercial future of the gas engine as a general motor depends.

A prominent factor in gas engine practice which has attained a high degree of development in European practice is the small gas producer. These generators are very simple in operation and furnish a convenient and economical means of obtaining power at a much lower rate than with the ordinary city lighting gas. Generally small anthracite coal or coke is used, but several methods employ bituminous coal, lignites or wood. With bituminous coal, means must be provided for removing the tar and ammonia and other products of distillation.

The process of generation in some of the more recent producers is entirely automatic and depends upon the demand of the engine, so that no storage capacity is required. The economy of these small producers is shown by tests which give one horse power on a 16 horse power engine with a consumption of only 1.1 pound of fuel. For engines above forty horse power one horse power can be obtained on seven-eighths pound of fuel.

The gas engine industry received a signal impetus when it was discovered that blast furnace gases could be readily utilized direct in combustion engines without the intervention of boilers and without any special purifying processes. A still more important circumstance which is far reaching in its results is the fact shown by Professor Hubert, of the Liege School of Mines, that the superior economy of the gas engine enables equal power to be obtained with 20 per cent less consumption of furnace gas than was formerly used in the generation of steam.

The successful employment of large combustion engines in this way utilizes vast sources of power which a few years ago were allowed to go to waste or at most were used very inefficiently.

The high thermal efficiency of the gas engine has long been recognized and the possibility of further development is a promising factor in this field. The already accomplished efficiency of 38 per cent reported by Professor Meyer, of Gottingen, greatly exceeds the maximum theoretical efficiency of the steam engine and more than doubles its actual best obtainable working efficiency, but the end is not yet.

With higher compression even greater efficiencies may be expected. But with high compression there is danger of premature explosion, due to the generation of heat in compressing the gas in the presence of oxygen; for this reason Herr Diesel compresses the air separately. Under a pressure of 500 pounds or more, which is used in the Diesel motors, the air becomes very hot and readily ignites a charge of liquid fuel which is injected into the compression chamber. There is no explosion; combustion occurs while expansion goes on and the heat generated disappears in the form of work.

Efficiencies of 30 per cent or more have been obtained with blast furnace gases which contain a very small percentage of hydrogen, and this with the high rates of compression which can be carried has led to the advocacy of non-hydrogenous mixtures in large engines. Certainly very high rates of compression may be had with a non-hydrogenous producer gas without fear of premature ignition, and it has the additional advantage of economical production.

The practice of making the cylinder in combustion engines act alternately, first as air compressor then as motor, has the advantage of greater simplicity, but it means immensely larger engines for the same power, since the number of effective impulses is thus cut in two.

The danger of pre-ignition and consequent severe shock on the engine also necessitates very heavy construction in the smaller engines in order to obtain a reasonable degree of safety in operation. Moreover, the smoothness of action is greatly retarded with this form of engine, especially if the governing is controlled by the "hit and miss" method, in which the regulation is effected by varying the frequency of the explosions, thus causing great variations in the driving torque.

Various expedients have been employed to overcome these defects, such as the use of multi-cylinders and different methods of control, but the size and cost of engine have been increased rather than decreased. Notwithstanding these well-recognized defects in the four-cycle type of engine, it constitutes by far the largest class in use to-day of what may be called successful gas engines.

More recently very satisfactory results have been obtained in the construction of two-cycle engines. In some of these we find separate pumps employed to compress the charge of gas and air, which ignites and burns as it enters the cylinder. Higher compression is thus obtained without fear of pre-ignition, and this permits smaller clearance spaces with attendant advantages.

If the engine is single-acting, an impulse is obtained every revolution, which thus insures better speed regulation, as well as double the power for a given sized cylinder.

The highest thermal efficiency yet attained, namely 38 per cent, has been secured with a two-cycle type of engine which compresses the air and gas in separate pumps to a nominal pressure of eight or ten pounds; the air under this pressure being used to scavenge the cylinder toward the end of the expansion. After the unconsumed products of combustion have been forced out by the fresh air, the cylinder walls having been cooled thereby, a charge of gas is admitted and compressed to a pressure of 150 to 175 pounds per square inch and then exploded, as in the usual method. This engine is double-acting and receives a charge each side of the piston; thus two impulses are received each revolution, in a manner precisely similar to that of a steam engine.

Whether these engines will be as satisfactory for small motors remains to be seen. It is possible that the greater complication of details in the two-cycle types, as compared with the simpler four-cycle engine, will cause the latter to continue to give the greater satisfaction, at least from the smaller sizes.

At the last meeting of the British Association, Mr. H. A. Humphrey gave some interesting data concerning recent gas engines, and the record is both remarkable and significant. The limiting size has rapidly grown during the past two years, as shown by the fact that one manufacturer is now constructing a gas engine of 2,500 horse power and is prepared to build up to 5,000 horse power.

The development of the large gas engine is closely connected with the evolution of the fuel gas processes, and it is noteworthy that the first gas engines in England above 400 horse power were operated with producer gas, while many of the large gas engines in Europe have been built for use with blast furnace gas.

In August of this year (1902) two leading English manufacturers had delivered or had under construction over fifty gas engines varying in size between 200 and 1,000 horse power; but we have to look across the Channel for still greater achievements in this direction.

Neglecting all engines below 200 horse power, we note that a classified list of gas engines in use or under construction shows the remarkable total of 327 gas engines capable of supplying 182,000 horse power. This gives an average of about 560 horse power per engine.

As compared with this we find from the last U. S. Census Report that, during the census year 1899, there were constructed in the United States 18,500 combustion engines having a total capacity of 165,000 horse power, or only about 9 horse power per engine.

Although this country has lagged somewhat behind Europe in adopting large gas engines, there is evidence that this state of affairs will not exist very long, for a number of enterprising firms are already in the field prepared to build gas engines up to any required size. One firm has already sold over 40,000 horse power of large engines, most of them of 2,000 horse power and several of 1,000 horse power. Another firm has recently built two 4,000 horse power gas compressors and also a number of 1,000 horse power gas engines.

The use to which these large engines are put is about equally divided between the operation of blowing engines for blast furnaces and the driving of dynamos for general power distribution; the tabulated list compiled by Mr. Humphrey for engines of more than 200 horse power shows 99,000 horse power for driving dynamos for light and power and 83,000 horse power for other purposes.

While the gas engine in the larger sizes is thus used extensively for the generation of electric light and power, a growing tendency is observed to use the gas engines direct as motors.

A number of railroad and other machine shops have

* Eng. Mag., October, 1902

† Geo. H. Lakes in Trans. Assn. Edison Illuminating Companies, July, 1902.

been equipped with moderate-sized gas engines suitably located about the works, and in addition, thousands of horse power are used in the small sizes for a wide variety of purposes, including village waterworks, isolated lighting stations, and manufacturing plants of all kinds.

With the possibilities of high thermal efficiencies we may look with much hope upon the still higher development of cheap fuel gas processes that will bring the gas engine into very general succession to the electric motor for many purposes, for it will doubtless be found that gas transmitted from a central gas-making plant at a manufacturing works into engines located at points of use will effect a material saving in the utilization of power over any existing methods.

It is not to be presumed that the gas engine will displace either the electric motor or the steam engine; each has its legitimate sphere of usefulness, and each will be more highly developed as the result of direct competition. Yet the economies already obtained indicate that the field of the gas engine will be extended more and more into that of the steam engine and the electric motor.

Many of the questions involved in this consideration are at the present time in a transitional stage. The reciprocating steam engine has reached a high state of development, but it is not probable that it has attained its highest degree of perfection. While an economy less than 9½ pounds of steam per horse power hour has been obtained, even better results may be anticipated; the use of high pressure superheated steam in compound, jacketed engines involves more perfect lubrication, and this may demand modification in existing valve types; however this may be, the outlook is promising for still higher efficiencies; whether this will mean cheaper power than can be obtained in other ways will depend upon many conditions.

In any case, and especially with intermittent or variable loads, it is not so much a question of maximum efficiency as it is economy of operation.

From this point of view the present activity in the construction and development of the steam turbine is of interest to engineers and power users. The steam consumption of a modern steam turbine of moderate size compares very favorably with that of the better class of large reciprocating engines, but what is of greater importance is the evident superior steam economy under variable loads. The steam consumption per horse power hour varies little from one-third to full load; at overloads the economy, as shown by numerous tests, may be even better.

This feature predestines the steam turbine to the special field of electric lighting and power generation, where it must inevitably become a formidable rival of the larger sized slow-speed reciprocating steam engine.

It is a significant fact that immediately following upon the installation of the large 8,000 horse power compound steam engines at the central station of the Manhattan Elevated Railway, New York, we find three 5,000 horse power steam turbines under construction for the Rapid Transit Company, of New York.

The high rotative speed of the steam turbine is a prominent factor in favor of its adoption in connection with electrical generators, since the cost of the generator end of the equipment ought eventually to be very materially reduced; but for many lines of work the high rotative speed of the present types of steam turbine is prohibitive, nor can it be adapted successfully to belt driving, except by the use of gearing. However, it is fair to presume that the present limitations of the steam turbine are not insuperable, and that the attention which is now being given to its development will evolve a more universal type of motor adapted to general power purposes with large and small units alike.

The economies already obtained with both the steam turbine and the gas engine have brought each into a prominence which is at least suggestive of the important developments that are taking place in methods of obtaining and using power.

THE NAVAL WAR GAME WAR BETWEEN THE UNITED STATES AND GERMANY.—VI.

By FRED. T. JANE.*

CRUSHING DEFEAT OF THE AMERICAN FLEET OFF MANILA.

THE German fleet, its transports and colliers well astern protected by destroyers, was found by the American scouts. These it made no attempt to drive back or evade as it shaped course for Manila. On the seventh parallel it altered course, and, passing through the Balabac Straits, came to anchor in the Bay of Islands in Palawai of the Philippine group. Here it coaled from its colliers as before, and spent four days in minor repairs.

The American fleet meanwhile lay at Manila, whither it had returned after a short cruise. It was compelled to keep the monitors with it, and these restricted its operations to a narrow sphere. In addition the American fleet had received fresh orders to the effect that it was not to fight unless absolutely necessary till the North Atlantic Squadron should be at hand.

Such orders were easy to issue, but when the German fleet, having weighed, proceeded to Pt. Sampaloc, near Manila, and there proceeded to land troops under the guns of the fleet, a fight became unavoidable. The American fleet, therefore, steamed out, not hoping for victory, but bent upon doing the maximum of damage before it should be annihilated—the destruction of the German transports being its special object. The two fleets were thus constituted:

BATTLESHIPS.

UNITED STATES.	GERMAN.
"Wisconsin" (flag).	"Wittelsbach" (flag).
"Oregon."	"Zaehringen" (flag).
"Illinois" (flag).	"Kaiser Barbarossa."
"Kentucky" (flag).	"Kaiser Wilhelm II."
	"Kaiser Karl VI."
	"Kaiser Friedrich III."
	"Kaiser Karl der Grosse."
MONITORS.	
"Monterey."	
"Monadnock."	
ARMORED CRUISERS.	
"Brooklyn."	
"New York."	"Bismarck."
CRUISERS.	
"Philadelphia."	"Nymphe."
"Albany."	"Niobe."
"Chicago."	8 destroyers.
"New Orleans."	
"Newark."	
4 destroyers.	

Both fleets were formed in this order in single line ahead, and the Germans standing away to the westward seemed to leave open the transports. The object of this attempt to get the American vessels inshore of themselves was fairly obvious, but as the Germans had the speed gage there was no way of preventing such a thing in the long run. The American admiral, the transports being his objective, made straight for them till the ships came within range. As they did so, both sides moved up destroyers, which in each fleet now took station on the off side of the battleships, the Germans to starboard, the Americans to port.

The Germans, as fire was opened, altered course to line abreast, but only for a short while and to bring all their ships into range. They were quickly in line ahead again, the entire fleet concentrating on the "Illinois," which ship, out of control, drifted out of the line and across the line of fire of some American vessels.

So soon as this happened she was let alone and fire bestowed upon the "Wisconsin;" thence it passed to the "Kentucky" and "Oregon," in each case being steady till a drifting wreck was the result.

All this while the German fleet, steaming its hardest, was slowly decreasing the range and nearing the head of the American line, which, compelled to do so to avoid being headed off, was continually bending to port and getting more and more in disorder. Soon it was a sagged line, the monitors nearly at the head of it, the other battleships at irregular intervals, and the cruisers in a bunch astern vainly endeavoring to get clear of the disabled "Illinois."

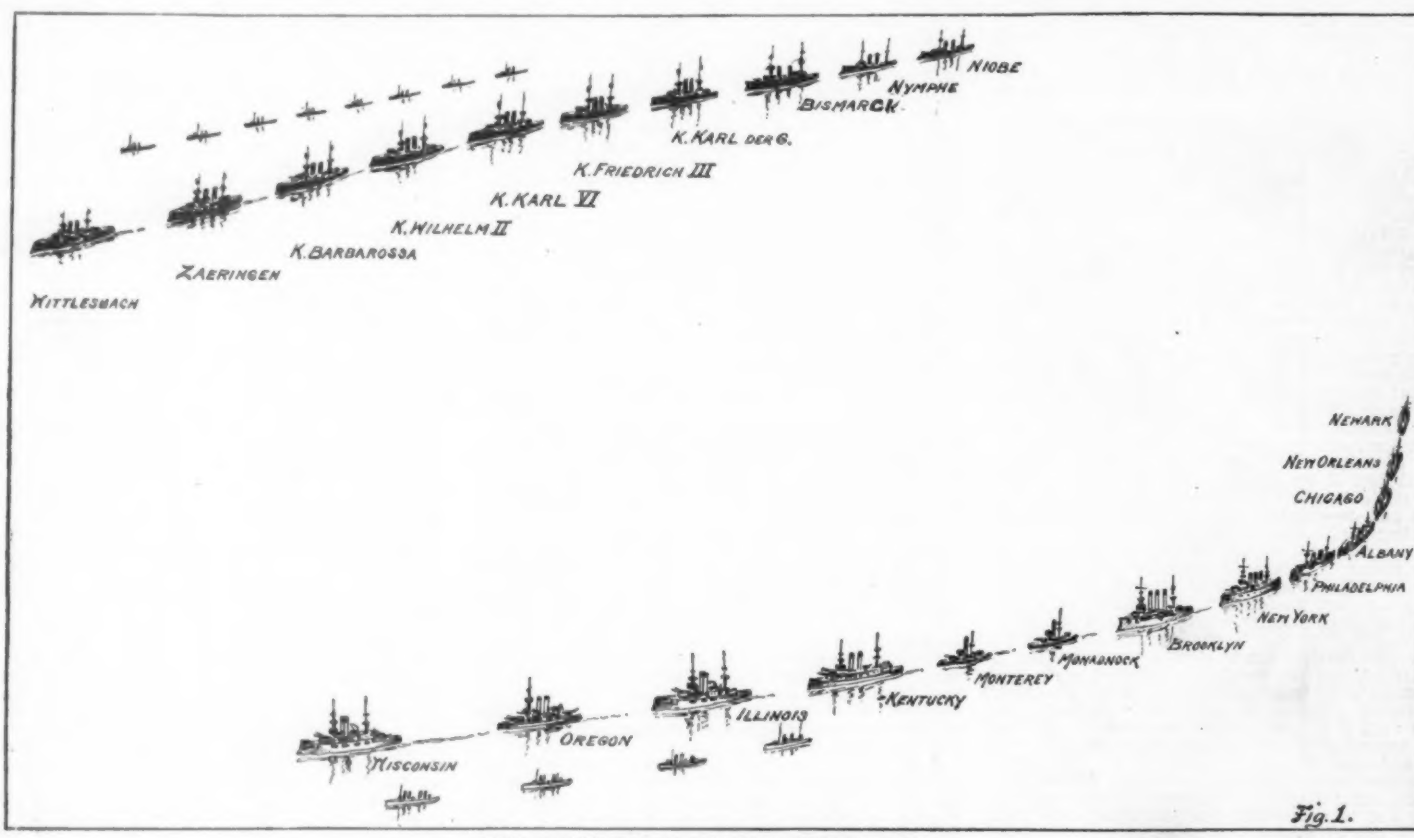
The American fleet had not been idle in its relatively feeble reply. Selecting the weaker, it inflicted enormous damage on the "Bismarck" (only lately repaired after the battle that opened the war), and both the "Kaiser Friedrich III." and "Kaiser Wilhelm II." were badly hit and had to drop astern.

These ships, as dropped, concentrated on the cruisers and disabled battleships so soon as their consorts cleared them. The rest meanwhile were now almost across the bows of the American line, concentrating a renewed fire on the "Wisconsin," now second in the line astern of the "Monterey" and ahead of the "Monadnock." With this tremendous fire there came a rush of the eight German destroyers, from behind the battleships, now less than three thousand yards distant. The four American boats steamed out to meet them, but the fire on the head of the American line was so fierce that one was hit and sunk at once. Then, as the Germans' fire shifted to the ships farther down the American line, to avoid hitting their own destroyers, a battle of small craft ensued. Three German destroyers were rammed or sunk, the three remaining Americans met a like fate. The other five German boats came on.

To meet them there were first of all the "Monterey," which carries practically nothing against torpedo craft. She was bows on. Astern of her the "Wisconsin" was terribly mauled, and also end on, a position in which the minimum number of guns could bear. She was also, owing to the concentrated fire that had played on her, unable to steer, consequently unable to bear her broadside.

Astern again was the "Monadnock," the "Kentucky" nearly abreast and masked by her. The "Oregon" was a long way astern of these two. Then came the "Illinois" and the cruisers, which opened out as well as they were able, with a view to firing on the oncoming destroyers. As the whole German fleet was firing into the midst of these vessels, they were able to contribute very little to check the boats. The latter had chosen the ideal moment to attack, and they secured the "Monterey," "Wisconsin," "Monadnock," and "Kentucky," with the loss of only one more boat. A second was sunk by cruiser fire a little later; the other two escaped by getting under the lee of the sinking "Wisconsin."

All the torpedoes of the boats were used in this attack, but the sight of the boats sufficed to keep back



THE BATTLE OFF MANILA—FIRST STAGE.

* Prepared especially for the SCIENTIFIC AMERICAN by the well-known naval expert and inventor of the naval war game; with exclusive rights in the United States and Great Britain. This series was begun in the SCIENTIFIC AMERICAN SUPPLEMENT of December 20, 1902.

the "Oregon." She turned away and tried to form some kind of line with the cruisers and the "Illinois," or rather such of them as were left in fighting condition.

From here onward the fight had no tactical interest; it was simply a massacre of ships retreating slowly to Manila, fighting to carry out the order to do all possible damage before going under. It did not last long; every American gun was matched against half a dozen German ones at this stage. It was also cut short by the return of the destroyers. These, having renewed their torpedoes, came in and gave a *coup de grace* to the two battleships—the cruisers save the "Albany" and "Brooklyn" were already accounted for by gunfire. These two vessels, the former little damaged, escaped into Manila—the sole remnants of the United States fleet. No pursuit was attempted. German ammunition was—it turned out—exhausted or nearly so.

The "Chicago" was sunk; the "New York" trying to crawl away was fouled by the disabled "Philadelphia," and captured, as also were the "Newark" and "New Orleans." This last, which had been little fired at, was taken; the other ships were so injured that, their crews having been removed, they were scuttled by the victors.

A list of the guns engaged is as follows:

UNITED STATES FLEET.

	13 in.	12 in.	10 in.	8 in.	6 in.	4.7 in. or 5 in.	4 in.
Wisconsin	4	..	..	.	14	..	..
Illinois	4	..	..	..	14	..	..
Oregon	4	..	..	8	4		..
Kentucky	4	..	.	4	..	14	..
Monterey	..	2	2	.	..	..	..
Monadnock	..	..	4	..	..	..	2
Brooklyn	..	.	..	8	..	12	..
New York	..	..	..	6	..	..	12
Philadelphia	..	..	..	..	12	..	.
Albany	..		..	..	6	4	..
New Orleans	..	..	..	..	6	4	.
Chicago	..		..	4	..	14	..
Newark	..		..	..	12	..	..
	16	2	6	30	68	48	14

GERMAN FLEET.

	9.4 in.	6 in.	4 in.	3.4 in.
Wittelsbach	4	18	..	12
Zaehringen	4	18	..	12
Kaiser Barbarossa	4	18	..	12
" Wilhelm II	4	18	..	12
" Karl VI	4	18	.	12
" Friedrich III	4	18	..	12
" Karl der Grosse	4	18	..	12
Fürst Bismarck*	2	6	..	4
Nymphe	..	..	10	..
Niobe	..	..	10	..
	30	132	20	88

* The "Bismarck" arrived from Kiao Chau on the same day that the Germans arrived off Manila from the south. The slight delay was made in order to effect this junction at the appointed day. The "Hertha" and "Hansa," which should have come also, did not arrive till after the battle. The reduced armament of the "Bismarck" is due to her previous battle.

Summarized, the guns stand thus:

	13 in.	12 in.	10 in.	9.4 in.	8 in.	6 in.	4.7 in. or 5 in.	4 in.	3.4 in.
United States	16	2	6	0	30	68	50	14	0
German	0	0	0	30	0	132	0	20	88

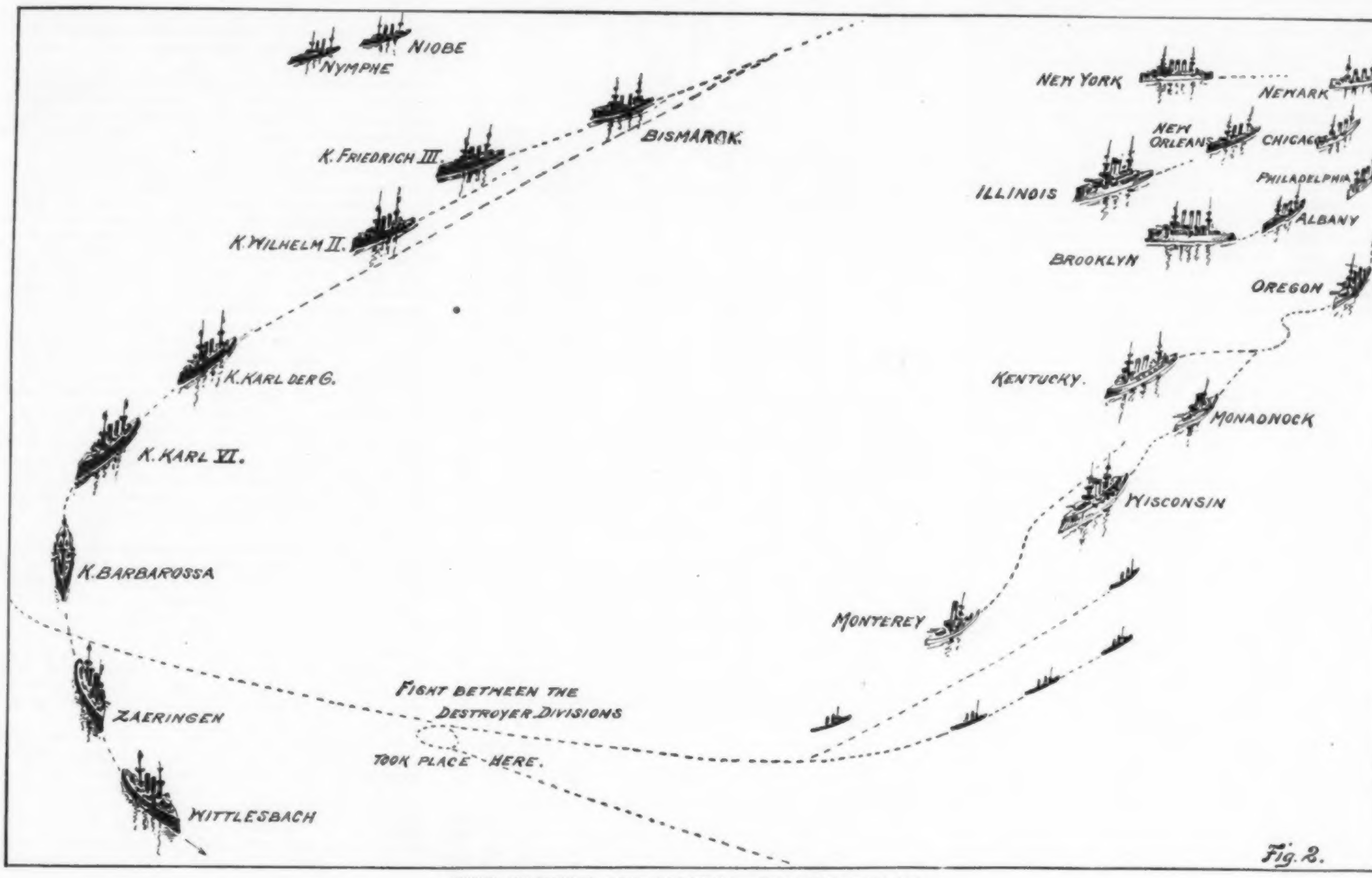
Here the German superiority in 6-inch guns is very marked, and it was the 6-inch and smaller pieces that settled the day. In the matter of big guns the disparity is small: the lesser caliber of the German pieces being more than made up for by the slower rate of fire of the heavy American guns. For the rest, we may say roughly that an 8-inch and a 6-inch come to much the same thing, because the latter is so much more rapid. Indeed, the United States 8-inch being mostly old guns might be reckoned inferior. Similarly, for any given time one 6-inch is roughly equal to two 5-inch (or 4.7-inch) and three 4-inch, which last are about on a par with the 3.4. Taking this approximation, we find that the armaments in minor pieces of 6-inch caliber or its equivalent were:

German	168
United States	*say* 128
German advantage	40

In addition of the German guns the 132 6-inch were all behind 6-inch armor. Of the 98 8 or 6-inch guns in the United States fleet, only 54 were protected by any armor save shields. Fourteen 5-inch in the "Kentucky" were so protected, but that only adds the equivalent of seven 6-inch to the United States total. Had the fight, therefore, been one of mere gunfire, the result could hardly have been different.

There was, however, the tactical advantage of the Germans, which was great. Their ships were homogeneous or nearly so, and they had the speed gage. The monitors clogged the American line and reduced its speed enormously. In addition, being inshore, they were very hampered, and unable to neutralize the German speed by turning to port as much as they might have in a seaway. The odds, in fine, were against the American fleet in every way.

(To be continued.)



THE BATTLE OFF MANILA—SECOND STAGE.

SAFFRON ESSENCE.

IT may not be generally known that by distilling saffron with water in an atmosphere of inert gas—carbonic acid, for example—a small quantity of essence is obtained, slightly colored yellow, possessing a very marked odor of the primary matter. The necessity for distilling in carbonic acid, or any other inert gas, arises from the fact that the essence has the property of absorbing the oxygen of the air quite easily, becoming thick and assuming a brownish color.

According to M. Roset, a member of the French Society of Civil Engineers, an elementary analysis of saffron essence will show that this is almost exclusively a terpene, which goes to show that the special odor of saffron would be due to small quantities of an oxygenated body. Saffron essence can also be obtained by heating picrocrocine (a bitter element of saffron) in an aqueous solution.

The Iridaceæ family (to which this belongs) supplies another and very interesting variety, especially from a perfumery point of view, namely, iris. The part containing the most perfume is the rhizome or underground stem of the plant. The following varieties of iris may be mentioned:

1. Iris Florentina, or Florence iris, a species possessing large white flowers, a native of the western and southern regions of the Black Sea.
2. Iris pallida, a plant with pale-blue flowers, growing wild in the calcareous soil of Istria.
3. Iris germanica, or tall iris, has dark-blue flowers, and grows in central and southern Europe, in the north of India, and Morocco.

The cultivation of these three varieties, though especially the last two, has been introduced and propagated in Florence and Lucca, where a very large trade is done in connection with them.

When fresh, iris root has a very unpleasant odor, but by desiccation it assumes a characteristic odor of violet. It is rather bitter to the taste, aromatic, and inclined to be acrid. This root is planted upon hills or the slopes of mountains, and never in valleys and rarely in open fields. It grows well in stony and dry soil, and is gathered at the end of three years, though if advanced it may be extracted in two years. The fresh rhizomes are placed in water to facilitate decortication, then laid out in rows and dried, which takes about fifteen days.

The principal depôts whence Florence iris root is exported are Leghorn, Verona, and Trieste. The root of Florence is used almost exclusively for distillation purposes, that of Verona, coming from the Iris germanica, being of inferior quality and very seldom distilled. The iris root of Morocco or Mogador, which also springs from the same variety, is even worse, being of a dark color, and not very odoriferous. The dark-colored roots are sometimes bleached by means of sulphuric acid; they cannot then, however, be used in the preparation of the essence.

By steam distillation, iris root only gives 0.1 to 0.2 of volatile oil. During this distillation the liquid gets very frothy, probably on account of the large amount of starch contained in the root; the operation is also a long and difficult one. With the object of making it simpler, certain authors have advised the addition of sulphuric acid so as to transform (partially, at any rate) the starch into glucose; it must be mentioned, however, that the essence obtained by means of this process has quite a special odor, which makes it inferior, in point of quality, to the essence obtained without having recourse to the sulphuric acid. Other authors aver that iris essence cannot be the normal product of the distillation of iris root, seeing that myristic acid does not become volatilized under the influence of water-steam. As it is recognized, however, that the steam operation produces some essence, and that this essence is principally composed of myristic acid, it must therefore be concluded, says M. Roset, that this acid has passed away in the distillation, and, consequently, that it is volatile under the influence of water-steam.

Whatever may be the case, however, the best process for preparing iris essence is the method by solvents. Ever since 1893, and even before, at a time when this process was very little known, M. Piver, of Aubervilliers, extracted iris essence rather extensively by means of sulphureted carbon in closed vessels. The iris root, reduced to a fine powder, was placed in contact with the sulphureted carbon in a closed vessel until exhausted. The sulphureted carbon was then vaporized, and the perfume obtained was rectified with five parts of alcohol.

The essence obtained by this process is of great

finesse. The method of extracting perfumes by means of volatile solvents has also been considerably improved upon, this method being now carried out quite systematically in a number of works. The apparatus which is employed is composed of a series of autoclave recipients, into which the flowers from which the perfume is to be extracted are placed. The solvent goes on to the fresh flowers, becoming concentrated progressively. The recipients are then successively emptied, when the flowers which they contained are drained off, and a continuous movement of the liquid which is used as a solvent will then be obtained by means of simple cocks. The final concentrated solution is evaporated by distillation (preferably under reduced pressure), and, lastly, in a final recipient, in which a hole is made. The mass will be very thick, being vigorously stirred, thus causing it to abandon the remainder of the solvent which it contains. The perfume thus obtained, known by the name of "concrete perfume," is a waxy-like mass of very great strength. It must, however, be rectified, so as to rid it of the last traces of solvent, which would alter the perfume. This, it should be noted, is a very delicate operation, and one which each manufacturer holds as a secret. These "concrete" perfumes are undoubtedly superior to those obtained by means of distillation by steam. Their *finesse* lies principally in the fact that the respective operations have been carried out without the intervention of heat, which always changes the odoriferous constituents of essences. It may likewise be mentioned that, even if the apparatus necessitated by this method be somewhat expensive, the manufacture is very economical; the solvent, which must be quite pure, is usually dear, but the least traces of it can be recovered by condensation. The nature of the solvent varies according to the perfume to be prepared, and sulphureted carbon, benzine, methyl chloride, petroleum ether, ether, and even chloroform, may be employed according to circumstances. Petroleum ether is, however, the solvent which is used in most applications. Another difficulty in respect to this method is the tenacity with which the vegetable matters remain dissolved, their elimination requiring great care. The employment of these "concrete" perfumes is (according to M. Roset, the author from whom we are quoting) becoming generally adopted in the perfumery trade in France on account of their being so convenient for exportation, for they contain an extraordinary strength in a very small volume.—Oils, Colours and Drysalteries.

INVAR AND ITS ADAPTATION TO HOROLOGY.

FEW watchmakers, etc., in this country are aware of the constitution of the remarkable alloy now called *invar*, and at first "the Guillaume alloy," because discovered by Dr. Guillaume, of the International Bureau of Weights and Measures, or "the Sevres alloy," because the investigations were conducted at Sevres, where the International Bureau has a complete equipment for the study of metals. Many may know that it is an alloy of steel and nickel and nothing more. If that were all, its properties might be vastly different. Its great value depends on an anomaly not previously discovered in any other alloy. The coefficient of dilatation increases until the proportion of nickel reaches 25 per cent, then decreases until at 36.2 per cent it is nearly at zero, and then increased again. The alloy is therefore made to contain just 36.2 per cent of nickel, so that a bar one meter in length is elongated less than a thousandth of a millimeter for 1 degree C.

It is this property which has suggested its use in horology. There was published not long ago an illustrated description of a pendulum whose rod was constructed of invar after designs prepared by Prof. Thury of the International Bureau. The alloy was at first supposed to be inapplicable to the construction of the balance and the balance spring, not so much from the difficulties of construction, as from the necessity that the co-efficient of elasticity should be independent of the temperature, which would involve another anomaly. But in the time-pieces produced by M. Paul Nardin of Locle and M. Paul Ditisheim of Chaux-de-Fonds, having balances constructed according to the suggestions of Dr. Guillaume, even the secondary error proceeding from the temperature between the degrees at which a watch is ordinarily adjusted was, as we have already informed our readers, almost entirely eliminated.

A paper published by Prof. Thury in the Journal Suisse d'Horlogerie gives the clearest and most succinct account of the properties of invar that we have seen, as well as the results of experiments on its elasticity conducted by himself, of which we will give a summary.

The alloy invar is magnetic, less so than steel and nearly the same as nickel. We have magnetized an invar rod by passing it through an electric coil. The magnetism, dilatation by heat, density, elastic force, hardness and tenacity of the nickel-steel alloys have been studied at the International Bureau of Weights and Measures. The tenacity of some of these alloys, which is greater than that of steel, suggested their employment in artillery. The researches at the International Bureau were first occasioned by noticing that a nickel-steel bar, which had been received from the French Artillery office, presented a coefficient of dilatation much greater than that which would have resulted from the simple mixture of the two metals, and nearly equal to that of bronze. On the other hand, a second bar of the same origin, with a percentage of nickel nearly as great as that of the first, presented a very low coefficient, about a third less than that of platinum. These anomalies led M. Guillaume to undertake a regular series of experiments on the variations of the coefficient of dilatation, corresponding to the successive increases in the percentage of nickel. These experiments were followed by others on seventeen graduated alloys, carefully prepared at the Commentry-four Chambault Steel Works, and furnished to the Bureau in the form of small bars 20 to 25 millimeters square, in section, and nearly a meter in length. These dimensions were convenient for exact processes.

The interest attaching to these researches resulted, both from their eminently practical bearing, and the great scientific importance of the theory of alloys. This dual consideration appears in the words of M. Guillaume in his first paper to the Academy of Sciences. "The dilatation, almost null, of certain nickel-steels is a remarkable anomaly, not hitherto presented by any other alloy. Its importance with reference to the construction of all kinds of instruments led me to pursue its study."

The results obtained have been detailed by M. Guillaume in two papers published in the Comptes Rendus de l'Academie des Sciences. The first contained a table of the coefficients of dilatation of the whole seventeen alloys; the second, a table of the density of modules of elasticity of the same alloys. It was quite difficult to obtain figures perfectly exact of the composition. Consequently some of the percentages in the first table were modified by new investigations and corrected in the second. These two tables are here united, giving for the proportion of the alloys the former and the corrected figures:

Alloys, Percentage in Nickel, 1st Estimate.	Alloys, Percentage in Nickel, 2d Estimate.	Density at 0 deg.	Module of Elasticity in Tons per square millimeter.	Average Coefficient of Dilatation between 0 deg. and T deg. $\times 10^{-6}$
	0	7.813	22.0	(10.354 + 0.00523 T)
	5	7.787	21.7	(10.529 + 0.00580 T)
12.2 + 1 Cr	12.4 + 1 Cr	7.898	19.0	(11.714 + 0.00508 T)
	16.8 + 1 Cr	7.802	18.3	(11.436 + 0.00170 T)
30	19	7.918	17.7	(11.427 + 0.00362 T)
	22	7.903	19.1	
21.8 + 3 Cr	22 + 3 Cr	8.034	19.7	(17.097 + 0.00974 T)
	24	8.111	19.3	(17.484 + 0.00711 T)
	26.2	8.096	18.5	(13.103 + 0.02123 T)
	28	—	18.1	(11.288 + 0.02889 T)
	30.8	8.049	16.0	(4.570 + 0.01194 T)
32	31.4	8.098	15.5	(3.395 + 0.00885 T)
35.5	34.6	8.066	15.1	(1.373 + 0.00237 T)
	36.1	8.098	14.7	(0.877 + 0.00127 T)
	36.4	8.082	14.9	(1.058 + 0.00220 T)
	36.6	8.086	15.0	(1.144 + 0.00171 T)
	37.5	8.005	14.7	(3.457 − 0.00647 T)
39.4	39.5	8.076	14.9	(5.357 − 0.00448 T)
44.4	44.5	8.120	16.4	(8.508 − 0.00251 T)
	100	8.862	21.6	(12.061 + 0.00550 T)

Alloys.—The knowledge of the exact composition and the composition itself rendered further researches desirable. In comparing the first and the last analyses the uncertainty of the percentage in nickel amounted to 1-30; besides, three of the alloys studied contained chromium (Cr) and they all contained small quantities of carbon, silica, manganese and phosphorus, in all about 1 per cent.

Coefficient of Dilatation.—For understanding the figures of this column, it may be stated that in the passage from the temperature of 0 degrees to that of T degrees, a bar of length L is lengthened by the quantity $L \times T$, multiplied by the result of the calculation indicated in the column. The second term, that which is multiplied by T, expresses the variation of the rates of lengthening with reference to the temperature. It would be null if the elongation of each unit of the bar remained proportional to the temperature.

To ascertain the lengthening of a bar at t' degrees to t'' degrees, it is sufficient to retrench from the length at 0 deg. to t'' deg. that at 0 deg. to t' deg. of the same bar; t'' is supposed to be greater than t'.

It must not be forgotten to multiply by 10^{-6}, or what amounts to the same thing, to divide by 1,000,000 each of the values resulting from the calculation indicated in the column of dilatations.

The very slight dilatation of the Sevres alloy may be considered as absolutely proportional to the temperatures within the limits of atmospheric temperatures. It is sufficient, therefore, to know that a bar 1 meter in length is elongated by 0.8 micron per degree of temperature.

Density.—The densities are all comprised between the density of nickel, 88.52, and that of steel, 78.13, except a small anomaly, perhaps merely apparent, for the 5 per cent alloy of nickel, but the densities do not follow the law of mixtures.

Modulus of Elasticity.—This is the weight which it will be necessary to suspend to a wire of 1 square millimeter in section, in order to obtain, if this were possible, an elastic elongation equal to the original length of the wire, which would be doubled. The module of elasticity of the alloys in the table is in every case less than that of steel, which is 22 tons. It reaches its smallest extent, 14.7 tons, or two-thirds of the module of steel, in alloys of minimum of dilatation (invar or very nearly invar); then again a little after, that is, with 37½ per cent of nickel.

Molecular Stability.—Designating the effect by the cause, the molecular stability is the perfect identity of the dimensions of a bar, when it returns to its position at the same temperature. Molecular instability usually appears in metals recently cast and worked; bronze and brass, for example. It disappears by a suitable reheating. These facts were noticed with Sevres alloy and are communicated by the Bureau to manufacturers.

For the alloys with 36 per cent of nickel the annealing seems to be complete in 24 hours at 150 deg. C.; in 100 hours at 100 deg. C.; in 300 hours at 60 deg. C., and in 700 hours at 40 deg. C. These lengthenings were followed for two months at the ordinary temperature, after which they became almost imperceptible.

Technic Qualities of the Alloy.—According to our experiments, the Sevres alloy is not susceptible of tempering, that is, of hardening by the effect of a change of temperature. A sheet of hammer-hardened invar has been heated to redness, then cooled slowly, or else suddenly by quenching with water. In both cases the metal became softer. Reheated, it is made harder again by the hammer or the rolling mill. The extent of the field of elasticity is then much augmented.

The hardness of invar, much greater than that of brass, equals or surpasses the hardness of iron.

Steel is a combination of iron susceptible of tempering. It is therefore not rational to apply the term nickel-steel to the alloy invar, which is not tempered.

Polished invar has a hue intermediate between the color of steel and yellowish nickel. It is grayish white, very slightly mixed with yellow, contrasting with the pure white of aluminium and of silver.

Resistance to Rust.—The alloys have not the almost perfect unchangeableness of pure nickel, yet the surfaces well polished resist for a long time the action of water, even at high temperatures. This resistance to the action of water increases with the percentage in nickel. The alloys the least dilatable, containing about 36 per cent of nickel, resist the attack so well that a graduated rule may be left for months in an atmosphere saturated with moisture without incurring spots of rust. In measuring the dilatation the rules remain for hours in warm water and are not wiped when taken out. They are able to remain afterward for a long time in steam without the designs traced on the polished surfaces being obscured. The rough surfaces, on the contrary, are covered in a few days with a continuous, though slightly adhering, coating of rust. The commencement of the attack should be carefully avoided. An ink spot produces a slight mark, which is intensified with water.

All the alloys are very sensitive to chlorhydric acid. If the soldering is not thoroughly washed, a serious attack on the surface may occur.

In experimenting on the thermic variations of the elasticity, I made use of a sheet of Sevres alloy 190 millimeters in length, 13 millimeters in width, and 0.35 millimeter in thickness. It was solidly fixed at one extremity in the inclined jaws of a vise. The free horizontal end carried a vertical index, a simple revolving needle; below the metal sheet a small cup was suspended at freedom to receive weights. By suitably inclining the vise, and with the adjustment of weights, the tangent drawn to the free extremity of the sheet could be brought into a horizontal position. The sheet itself described an elastic curve from the vise to the index. The index and the cup, with their common support, weighed together a little less than ten grammes. The tangents drawn to the two extremities of the sheet formed between them an angle of about 157½ degrees in the ordinary conditions of the experiment, and with the weight of one gramme in the cup. The index was then vertical, notwithstanding the considerable curvature of the metallic sheet.

A good cathetometer, divided into fiftieths of a millimeter, with a strong lens (objective 00 of the Siebert microscope), was placed opposite the index on the marble slab, which also supported the vise. I did not use a stove, but utilized the daily variations of the temperature of the place, which varied from 15 deg. to 37 deg. C.

The result surprised me a good deal. Instead of the difference of most other metals, which yield to the heat, invar preserved its position. Its coefficient of elasticity, instead of diminishing, augmented with the rise of temperature, at least within the limits in which I operated; that is, between +15 deg. and +37 deg. C. Consequently, a balance spring of invar would cause the watch to gain under the influence of heat, but compensation might be effected by the simultaneous employment of two springs, one of invar, the other of steel.

In search of the possible causes of error, the effect of the thermic dilatations of the different parts of the apparatus made use of were determined by calculation and by experiment. Then the observations were multiplied by modifying the apparatus and its mode of employment, without forgetting the return of the elastic plate to its position. Each experiment was continued, as far as possible, in such a way as to obtain a complete cycle; that is, a return to the temperature at starting; the return was always observed as approximating very nearly to the initial elastic tension. The definitive changes produced by the thermic variations surpassed about thirtyfold the figure of the uncertainty of the measures.

It was thus that by the effect of a thermic variation of 17 deg. C. (+18.2 to +35.2) the vertical height of the index changed 0.665 millimeter. If the figure of the error is estimated at 0.02 millimeter it would be 1-32 part of the quantity measured. The weight of one gramme put in the cup diminishes the vertical ordinate to the extent of 3.9 millimeters. The ordinates may thus be translated into corresponding weights, and as 0.65 millimeter is contained 6 times in 3.9 millimeters, it is seen that the thermic variation for 17 deg. C. of temperature may rise to about one-sixth of the elastic variation considered as independent of the temperature.

The above is a very simple sketch of my researches. The result is made known to watchmakers to aid them in making new applications of invar.

I have received a full communication from M. Cailler (Professor of Mechanics in the University of Geneva), whom I requested to make a more complete elucidation of the point which I referred to in describing the new compensating pendulum.*

I will not now take up the intricate mathematical calculations of M. Cailler, but will give the conclusions:

1. Whatever may be the dimensions of the bob and the material of which it is composed, it may be suspended at such a point that the compensation shall be exactly realized.

2. The situation of this point of attachment may be determined theoretically by an equation of the third degree, of which the necessary elements are the three bodies which compose the pendulum, the rod, the compensating tube and the bob.

* This point related to the suspension of the bob. The length of the seconds pendulum is calculated for Switzerland at 995 millimeters. A pendulum of invar not compensated would lengthen eight thousandths of a millimeter for an increase of ten degrees in the temperature, and the clock would lose about one third of a second in twenty-four hours, a very small fraction as compared with a pendulum of any other metal. This error may be corrected by a dilatable tube sheathing the lower part of the pendulum rod, and resting on an adjusting screw-nut made of invar, the upper extremity of the tube supporting the bob a little below its center of gravity, nearly at the center of oscillation of the system. In order to be exactly at the center of oscillation, it would be necessary that the center of oscillation of the bob alone, and that of the pendulum free from the bob, should both be at the same distance from the center of movement. This was the point which Prof. Cailler was requested to elucidate.—Note by Translator.

THE PRESENT STATE OF WIRELESS TELEGRAPHY.

It is now eighteen months since we last attempted in these columns to take a general survey of the development of wireless telegraphy. In the history of a science which has enlisted the services of so many skilled experimentalists, each of whom has made rapid progress along his own lines, eighteen months is a comparatively long period; as a result, we are compelled to-day to regard the subject from a very different point of view. At that time, there were practically only two systems—Mr. Marconi's and Prof. Slaby's—which had advanced to such a degree of perfection that they deserved special consideration. To-day, it would hardly be too much to say that in every civilized nation there are one or more inventors with a carefully worked-out and tested system ready for general use. Particulars of these different systems have been published from time to time and have been duly referred to in Nature; unfortunately, the information published is not, as a rule, of the kind that one most desires to obtain; too often it is obviously "inspired," and consists for the most part of insufficiently supported claims to successful syntonization, or to record making in the way of long-distance transmission or rapid signaling, information which is very acceptable to the daily papers, which forget one day what they have published the day before, but of little use to those who are seriously interested in the subject.

So far as can be judged, the various systems differ chiefly in matters of detail, the design of circuits and the special construction and arrangement of apparatus; improvements depending on the introduction of a principle fundamentally new are few and far between. We do not wish to underrate the value of these detailed improvements; they are, as we well know, often the talismans converting failure into success, but their interest is mainly for the specialist. It is not our intention, therefore, to enter into a detailed examination of the different systems; to do so would only involve us in a mass of technicalities from which the reader would probably "come out by that same door where in he went." Those who wish for this information must be referred to the technical press or to the files in the Patent Office, where they will probably find, as for example, in the two hundred odd claims in Mr. Fessenden's patents, all the particulars they desire. We propose rather to treat the subject on a broader basis, and to endeavor to form an estimate of how far wireless telegraphy in its present state has fulfilled the expectations that have been raised in the past or justifies hopes that may now be entertained for a future of wide utility.

The first question that one feels inclined to ask is, At what end are all these inventors aiming? Is it to devise a system of wireless telegraphy to compete with ordinary telegraphic methods, or is it for what seems to us the more useful purpose of creating a means of communication where none now exists, especially between ship and ship and ship and shore? It would seem that in some instances, as, for example, that of the Marconi Company, the former purpose is almost as much in view as the latter. In the former case, there can be no question but that absolute syntonization is necessary; in the latter, it is less important and even in some respects undesirable, but, on the other hand, it is essential that the different systems should work together so that any ship should be able to signal to any station. It would be a great misfortune if this principle is lost sight of in the rivalry between competing methods and if we thereby lose what seems to be in reality the greatest benefit wireless telegraphy can confer, the increase of the safety and convenience of traveling by sea. This is, we think, the most urgent problem that wireless telegraphy presents to-day, and we trust that it will find

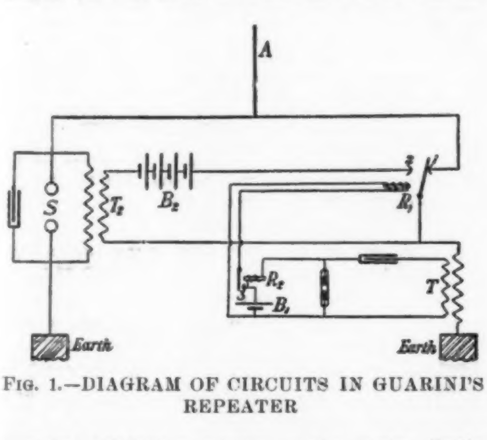


FIG. 1.—DIAGRAM OF CIRCUITS IN GUARINI'S REPEATER

a really satisfactory solution at the coming Berlin Conference.

The attempts which have been made at syntonization are, indeed, far from encouraging. It is true that almost every inventor claims that he has solved the problem, but all the experiments that have been quoted are open to criticism. It is important to recognize what a successful solution really means; it is not sufficient to demonstrate, as has been done many times, that two messages can be transmitted or received at the same time by the same installation without interference; that, in short, duplexing is possible. This is a great step, no doubt, but to solve the problem it is necessary that the tuned transmitter shall affect no other receivers than those syntonized with it, and that the tuned receiver shall respond only to the proper waves; this, it will be seen, is a requirement much harder to satisfy. As an example, showing how far existing practice is from satisfying these conditions, we may quote the case of the recent long-distance work done by the Marconi Company. Mr. Marconi, it will be remembered, has several times claimed to have solved the problem of syntonization, and, confident of having done so, issued a challenge last February to Sir W. Preece or Sir O. Lodge to intercept any of his messages, offering to put a station, in the neighborhood of his Poldhu station at their service. This challenge has been answered in a conclusive manner during the past month by Mr. Nevil Maskelyne, who showed that the installation which he was working at Portcurnow had been receiving the messages sent to the "Carlo Alberto" on her recent cruise from England to Italy (see the Electrician, vol. l., pp. 22 and 105). It is clear, therefore, that with no special preparation on either side, it is possible to tap the signals that are being sent by the Marconi Company over long distances, and in face of this the claims to a real solution of the syntonization problem fall to the ground. We doubt whether any other system would stand the same test.

But if on this side the outlook is somewhat dispiriting, in other directions matters are more encouraging. This year has witnessed the remarkable

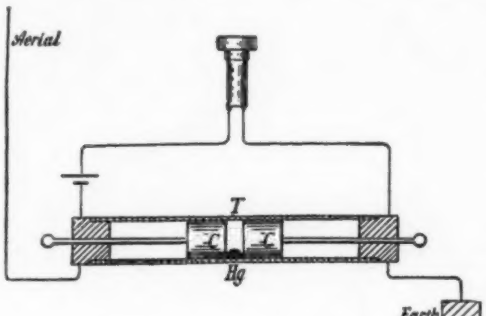


FIG. 2.—CASTELLI COHERER AND CONNECTIONS.

achievements by the Marconi Company in long-distance work. It has been shown that it is possible to signal across the Atlantic, a distance of more than 2,000 miles over water; and in the cruise of the "Carlo Alberto" signals were transmitted a distance of 750 miles over land and water. To cover these great distances, the power used at the transmitting station has to be correspondingly great; in consequence, the signaling was only from Poldhu to the ship and not in the reverse direction. The importance of these experiments, however, lies rather in the conclusive demonstration of the fact that it is only a question of providing sufficient power to signal over any distance, however great, and therefore no fears need be entertained of the utility of the wireless telegraph being limited by considerations of distance. No other experimenter has attained such success in long-distance work as Mr. Marconi, but no other experimenter has used such large power for transmission. Unfortunately, sufficient particulars are not available to enable a comparison to be made between the distances attained with different systems using the same amount of power; this is a point on which the publication of trustworthy data would be of the highest value. An interesting phenomenon brought out by Mr. Marconi's long-distance work is the effect produced by daylight on transmission. It is found that the signals carry much further during the night (i. e., night at the transmitting station), the result being due, it is suggested, to the discharging effect of sunlight on the aerial wire (see Nature, vol. lxvi., p. 385).

With reference to long-distance work, the interesting experiments of M. Guarini with an automatic repeater may be quoted. This inventor designed an apparatus which would pick up a message received from one station, *A*, and pass it on to a second station, *B*, which was out of the range of the signals transmitted direct from *A*. The principle of this apparatus will be understood from the accompanying diagram (Fig. 1) in which, for the sake of clearness, only the essential circuits are shown. The aerial wire, *A*, at the repeating station is connected through the contact, *1*, of the relay, R_1, and through the primary of a transformer, *T*, to earth; it is also connected through the spark gap, *S*, to earth. The coherer is connected in series with the secondary of *T* and a condenser. When a signal is received, the resistance of the coherer is broken down, and the battery, B_1, sends a current through it and the relay, R_2, thus closing at the contact 3 the circuit of the relay, R_1. The contact arm of R_1 swings over to 2, thus disconnecting the aerial from the receiving circuit and closing the primary of the induction coil, T_2, thereby causing a spark to pass across the gap, which means that the signal is sent out again from the aerial, *A*. The coherer being tapped back, the various circuits are opened, and the arm of R_1 returns to its original position and so is ready to receive the next signal. Experiments were carried out between Antwerp and Brussels (42 km.), the repeating station being at Malines, about half-way between the two; the results were promising, though the repeater did not prove absolutely trustworthy.

We may now turn from the consideration of the results achieved to the apparatus that has been used. In the transmitting apparatus, attention has been chiefly devoted to devising means of generating oscillations of definite wave-length. None of these call for special comment. In some cases, for obtaining the spark, alternating-current generators have been employed in connection with step-up transformers instead of induction coils. This is the case in the De Forest system, which, it may be remarked, claims the record for speed of forty-eight words per minute; the alternator generates, at 500 volts, 60 cycles, and this is stepped up to 25,000 volts for sparking; the signals are formed by interrupting the primary circuit of the transformer by means of a specially-designed key. The difficulty of breaking a large current in this way is considerable and has obviously proved a stumbling-block to the Marconi Company, as it forms the subject-matter of two or three patents taken out by Prof. Fleming and the company. Some of the methods described therein are exceedingly ingenious, but, unfortunately, space does not allow us to describe them here, especially as their bearing on wireless telegraphy is only indirect.

With the exception of the magnetic detector devised by Mr. Marconi and tested during the cruise of the "Carlo Alberto," practically all the different systems make use of the coherer principle for receiving. The actual type of coherer used differs considerably in the several cases. For long-distance work, it has generally been found most suitable to use a coherer which requires no tapping back, but spontaneously returns to its normal condition, this being connected in parallel with a telephone. One of the chief advantages of this arrangement lies in the fact that the energy required to give audible signals in the telephone is much less than that needed to work a relay. There are several different coherers working on this principle—the principle really of the microphone; in the system devised by M. Popoff, carbon granules form the loose contacts, the resistance, which is normally high, being broken down by the received waves and the coherer then restoring itself to its original condition; the change in the current through the coherer causes a click in the telephone. In the De Forest system, an electrolytic "anticoherer" is used; this has a paste, composed of a viscous material, loose, conducting particles and an electrolyte between suitable electrodes. In the normal condition, the conducting particles bridge the gap and give the receiver a low resistance; electrolysis is set up by the received oscillations and the consequent polarization greatly increases the resistance. Of the coherers of this type, the greatest interest attaches to the Castelli coherer. This, invented by a semaphorist in the Italian navy, was used by Mr. Marconi in his first transatlantic experiments. Its construction is shown in Fig. 2. Two iron or carbon electrodes, *C C*, fit into the tube, *T*, and are connected by a single drop of mercury, *Hg*. The connections shown are, of course, the same in the case of the two other coherers just described. When electrical oscillations reach the tube, the mercury coheres to the electrodes, but returns at once to its normal condition when the stimulus ceases. The magnetic detector to which we have made reference above was described by Mr. Marconi in a paper read before the Royal Society last June. Fig. 3 shows the principle of its construction. It consists of a core of thin iron wires, *I*, over which are wound two coils of fine copper wire, C_1 and C_2. The outer core, C_1, is connected to a telephone receiver and the inner, C_2, to the aërial and earth or to the secondary of a transformer the primary of which is connected to the aërial and earth. The iron core is magnetized by a permanent magnet, *M*, at one end, which is rotated by clockwork so as to produce a continual slow change in the magnetization which, however, owing to the hysteresis, lags behind the magnetizing force. When oscillatory currents pass through the inner coil, there is a sudden decrease in the hysteresis, due apparently to the molecules being released from restraint; a corresponding sudden variation in the magnetization of the iron results, and this induces a current in the outer winding connected to the telephone.

Such, in brief, are the more important advances that have been made in the practice of wireless telegraphy during the past year. In addition, much work has been done on the purely scientific side of the subject, the action of the coherer in particular having been submitted to somewhat rigorous examination, work which has already produced results which may prove both of great physical and great practical value. It may fairly be said that we know now, with a considerable degree of certainty, some of the more useful services which wireless telegraphy may be relied upon to perform. Already its commercial application is considerable; many ships, in the navies of this and other countries and in the merchant services, are equipped with wireless telegraphic apparatus which

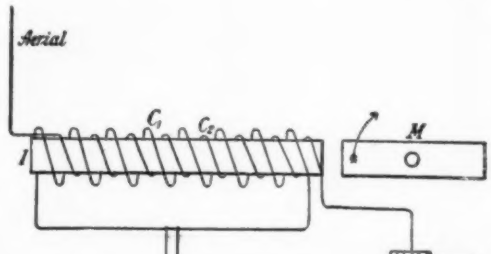


FIG. 3.—DIAGRAM OF MARCONI'S DETECTOR.

has we believe, fully justified its installation. It is in this direction that we look with the most confidence for a steady increase in its application, and we would rather hear of a few more ships being thus equipped than of another "S" being transmitted across the Atlantic.—Maurice Solomon in Nature.

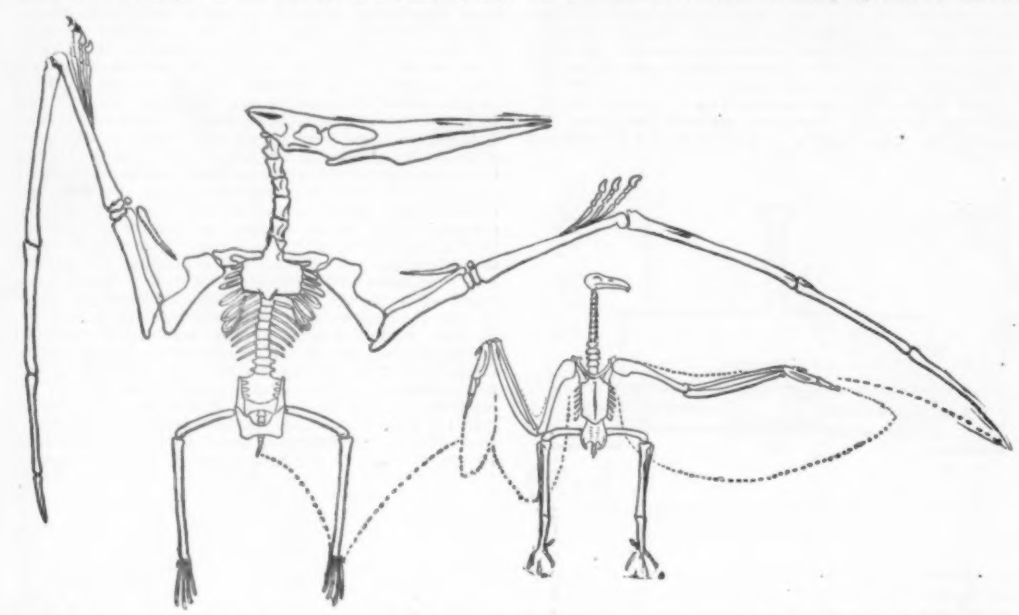
Solar Protuberances and Terrestrial Magnetism—Sir Norman Lockyer has studied the astronomical observations by Tacchini, Ricco and others with a view to discover some connection between solar phenomena and terrestrial magnetism. He has arrived at the following interesting conclusions as regards the frequency of visible protuberances in the different latitudes of the sun and magnetic storms: (1) That the epochs of magnetic storms classed by Ellis as "great," and those of the greatest chromospheric activity of the sun *near its poles* are identical; (2) that the general curve of terrestrial magnetic activity is nearly the same as that of the protuberances near the solar equator.—Sir N. Lockyer, Comptes Rendus, August 25, 1902.

THE GREATEST FLYING CREATURE.*

By S. P. LANGLEY.

(Introducing a paper by F. A. Lucas.)

A QUESTION of interest to all who are attracted to the subject of aerial navigation by flying machines (or things heavier than the air, and which, therefore, do not float like a balloon, but are dependent entirely on some mechanical power for their support) is, "What has nature herself done in the way of large flying machines, and are the birds which we see now the limit of her ability to construct them?"



SKELETON OF THE GREAT PTERODACTYL ORNITHOSTOMA COMPARED WITH THAT OF THE CONDOR.

The Pterodactyl after a figure by Prof. S. W. Williston.

In former epochs of our planet's history there were larger flying creatures than now, notably the pterodactyl, "a brother to dragons," a reptile rather than a bird, but a reptile with enormously great wings. We do not know just how great this was in the living creature, except conjecturally, for we have only the skeleton. To take the expanse of the wing skeleton of a bird as giving us the expanse of wing of the actual bird would be to greatly underestimate it, the stretch of the skeleton being much less. The skeleton (which is all we have left of the pterodactyl, a featherless reptile, and in that important respect different from a bird) will be more nearly in expanse that of the living creature.

We have here in the illustration a larger than ordinary specimen of ornithostoma, a pterodactyl whose skeleton indicates a spread of wing of about twenty feet.

It is compared with that of the condor, nearly the largest bird now on the planet.

For my immediate purpose I will recall to the reader that birds are divisible into two classes: (1) those who soar with little motion of their wings, and yet in some mysterious manner keep their generally weighty bodies afloat on the yielding air, and (2) those who flap their wings.

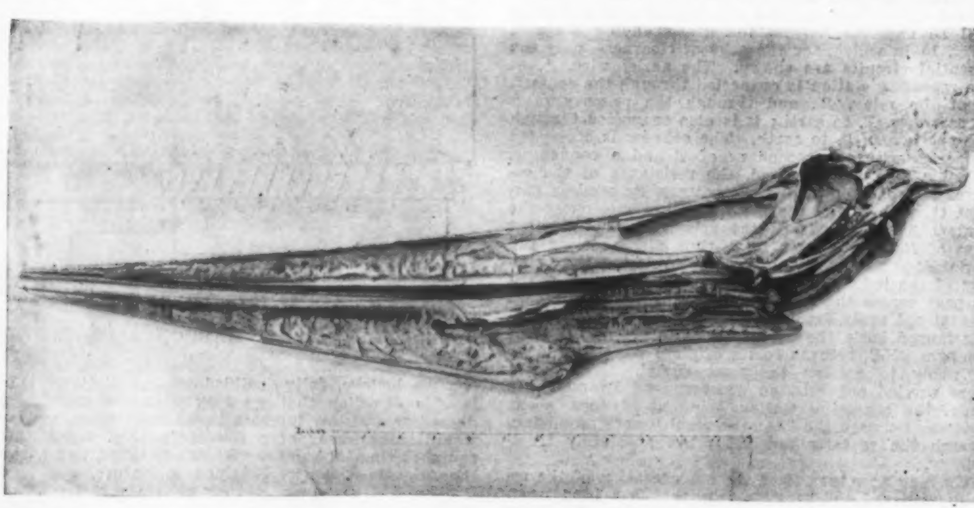
Ornithostoma belongs almost unquestionably to the first of these classes. Its weight is not to be exactly estimated, but from a variety of considerations, part of which are quoted by Mr. Lucas in the ensuing paper, it is possible that the average specimen of ornithostoma, in spite of its great wing space, did not weigh over thirty pounds.

Now we wish for our especial purpose of comparing this bird with other flying things, to know (*a*) the supporting area in square feet, (*b*) the weight, and (*c*) the power for (1) a flying machine of man's invention, which has actually flown for comparatively long distances, (2) like facts for this the largest of nature's flying machines, and (3) for some of our present birds. To recapitulate, we need for our special purpose at least the following data for any flying thing, namely, (1) the supporting area in square feet, (2) the weight in pounds, and (3) the horse power which drives it through the air.

It is evidently impossible to exactly recover all these for the pterodactyl, and hard to definitely establish all three even in living specimens, but we may assume in the case of the horse power that it is proportioned to the area of the attachment of the muscles which moved the bird in flight, an assumption which is doubtless only approximately true, but may serve our immediate purpose. The steel flying machine taken in an instantaneous photograph had a supporting area of 54 square feet, a weight of 30 pounds, developed 1½ horse power, and repeatedly flew from one-half a mile to three-quarters of a mile. These facts are represented in the diagram by the three rectangular figures whose areas are proportional to these values. Immediately after it comes nature's greatest flying machine, the pterodactyl. This may have been quite 20 feet from tip to tip of wing. The paleontologist says that approximately the wing surface was 25 square feet, the weight something like 30 pounds, and I infer from the consideration just quoted that the power was probably less than 0.05 horse power, the immensely greater economy and efficiency of nature in the respect of power being most strikingly shown by the size of the small rectangle as compared with that in the flying machine of man's invention.

After this comes the condor, pre-eminently a soarer. Its stretch of wing is 9 to 10 feet, its supporting area very nearly 10 square feet, its weight 17 pounds, and the approximate horse power it develops (inferred from the facts already stated) scarcely 0.05.

Next comes the turkey buzzard, whose stretch of wing is 6 feet, its supporting area a little over 5 square feet, its weight 5 pounds, and the approximate horse power it develops (as above) 0.015.



SKULL OF THE GREAT PTERODACTYL ORNITHOSTOMA.

From a specimen in the Yale University Museum.

All the above are soaring birds. I now pass to another order of birds, which flap their wings. The wild goose, with a supporting area of 2.7 square feet, has a weight of 9 pounds, and needs a proportionately greater power of nearly 0.026 horse power to drive it, as against scarcely 0.02 horse power in the last example.

Next we have another familiar bird, the pigeon, which drives itself by flapping the wings. This has an area of about 0.7 of 1 square foot, a weight of 1 pound, and a horse power of 0.012.

Below this we come to the humming bird, whose area, being shown on the same scale as the others, is almost too small to be distinguished on the page, but which has a supporting surface of nearly 0.03 of a square foot, a weight less than 0.02 of a pound, and a horse power of probably not over 0.001. (All these values, as we have already said, are but approximative.)

Particular attention is to be paid to the fact that regarding the ratios of supporting surface to weight supported, these ratios are not only not the same in all the birds, but themselves differ greatly, but systematically, with the absolute weight. If we inquire how much 1 horse power would support, for instance, supposing the ratios of sustaining surface (i. e., wing area) to weight to be constant, we find that 1 horse power would, in the flying machine, support 20 pounds with 36 square feet area of wing (i. e., 1¾ square feet to a pound); and that, passing to the flapping birds, if the wild goose were to preserve the same relations on an enlarged scale, its 1 horse power would support 346 pounds of weight with the use of 101 square feet of wing surface or 0.29 square feet to the pound; that in the pigeon 1 horse power would support 83 pounds of weight with the use of 58 square feet of wing surface or 0.7 square feet to the pound, and that in the humming bird 1 horse power would support 15 pounds of weight with the use of 26 square feet of wing surface or 1.73 square feet to the pound. So that, broadly speaking, so far as these few examples go, the larger the creature the less relative surface and power is needed for its support.

From the obvious mathematical law that the area in bodies in general increases as the square of their dimensions, while their weight increases as the cube, it is an apparently plain inference that the larger the creature or machine the less the relative area of support may be (that is, if we consider the mathematical relationship, without reference to the question whether this diminished support is actually physically sufficient or not), so that we soon reach a condition where we cannot imagine flight possible. Thus, if in a soaring bird which we may suppose to weigh 2 pounds we should find that it had 2 square feet of surface, or a ratio of a foot to a pound, it would follow from the law just stated that in a soaring bird of twice the dimensions we would have a weight of 16 pounds and an area of 8 square feet, or only half a square foot of supporting area to the pound of weight, so that if flight is possible in the first case it would appear to be highly improbable in the second. The difficulty grows greater as we increase the size, for when we have a creature of three times the dimensions we shall have twenty-seven times the weight and only nine times the sustaining surface, which is but one-third of a foot to a pound. This is a consequence of a mathematical law, from which it would appear to follow that we cannot have a flying creature much greater than a limit of area like the condor, unless endued with extraordinary strength of wing.

But this apparently necessary mathematical consequence is not the law of nature, for while it is found that in the larger bird a smaller area for each pound of the weight is given under the law than in the smaller bird, it is also found (what is another thing) that this smaller area is nevertheless sufficient, and that from the mathematical law just cited there does not follow the apparently obvious consequence (notably in the larger creatures like the condor, perhaps less notably in such a creature as the pterodactyl) that the bird cannot be supported, and while the fact is certain that it can, the cause of this does not seem to be clearly known.

Special cases, it may be said, may furnish an exception to what in the nature of things must be the general rule. Such, however, again does not seem to be the fact. This anomaly, which is even now not generally appreciated, seems to have been first noticed by a French observer, M de Lucy, who about 1868 published a memoir, which I have not seen in the original, but an English translation of which was published in the Fourth Annual Report of the Aeronautical Society of Great Britain for 1869, and an extract from which is here reproduced. The same facts are given at greater length in an article by Dr. Karl Müllenhoff, of Berlin, in the Archiv für die Gesammte Physiologie, volume xxxv.

M. de Lucy's table.

[From the Fourth Annual Report of the Aeronautical Society of Great Britain for 1869, page 63.]

INSECTS.

Names.	Square feet of wing surface per pound of weight.
Gnat	49
Dragon fly (small)	30
Coccinella (ladybird)	26.6
Dragon fly (common)	21.6
Tipula, or daddy longlegs	14.5
Bee	5.25
Meat fly	5.6
Drone (blue)	5.08
Cockchafer	5.15
Lucanus cervus, stag beetle (female)	4.66
Lucanus cervus, stag beetle (male)	3.75
Rhinoceros beetle	3.14

BIRDS.

Swallow	4.82
Sparrow	2.72
Turtle dove	2.13
Pigeon	1.25

In this table each creature is supposed to be magnified or diminished in all its existing proportions till it weighs 1 pound. The surface dimensions of its wings will then be as given.

The above insects and birds vibrate their wings and do not soar. The table shows that the law (i. e., the law that the larger the creature the less the necessary relative area of support to a given weight) holds not only in the case of the large soaring bird, but in the case of smaller ones which flap their wings, and even

* From Smithsonian Report for 1901-1902.

in the case of insects. The explanation may be very near at hand, but it is not to me evident.

The accompanying table, from Mouillard's L'Empire de l'Air, deals with the same facts, and exhibits the paradoxical law that the greater the creature the smaller the (relative) supporting surface:

*Table showing weight, wing area, and square feet of wing surface which sustains 1 pound of weight.**

Latin Name.	Common Name.	Weight in pounds.	Wing surface in square feet.	Square feet of wing surface per pound of weight.
Scops zorca	Screech owl	0.33	0.776	2.35
Accipiter nisus	Sparrow hawk	.336	.69	2.05
Larus melanocephalus	Black-headed gull	— .619	.92	1.49
Astur palumbarius	Goshawk	— .641	.84	1.31
Otus brachyotus	Short-eared owl	— .67	1.50	2.24
Ibis falcinellus	Glossy ibis	— .806	1.24	1.54
Corvus corax	Raven	— 1.34	2.50	1.87
Milvus ægyptiacus	Kite	— 1.41	3.02	2.14
Pandion haliaetus	Fishhawk	— 2.80	3.01	1.08
Neophron percnopterus	Scavenger vulture	— 3.83	3.65	.95
Cathartes aura	Turkey buzzard	— 5.6	5.33	.95
Pelecanus onocrotalus	White pelican	— 6.66	6.32	.95
Phœnicopterus antiquorum	Flamingo	— 6.34	3.50	.55
Gyps fulvus	Griffon vulture	—16.52	11.38	.68
Sarcorhamphus gryphus	Condor	—16.52	9.80	.59
Otogyps auricularis	Eared vulture	17.76	11.99	.68

* Data compiled chiefly from Mouillard, L. P., L'Empire de l'Air, Paris, 1881.

The curve (published herewith) shows the same facts in a graphic form, and they seem to me to deserve a fuller explanation than has yet been given to them.

I now invite the reader's attention to Mr. Lucas's interesting paper. S. P. LANGLEY.

THE GREATEST FLYING CREATURE, THE GREAT PTERODACTYL ORNITHOSTOMA.

By F. A. LUCAS.

United States National Museum.

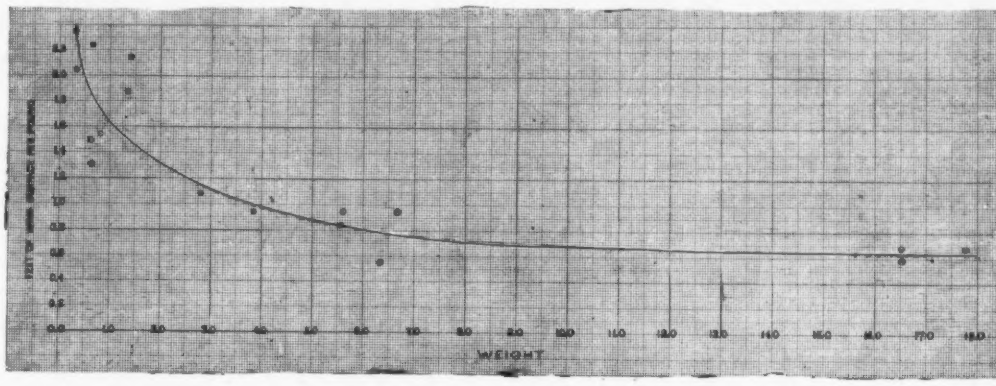
No one animal combines all the best features of weight, power, and wing area needed in a flying machine, for those with the greatest expanse of wing are by no means the heaviest and strongest, while the most powerful birds are not those of the longest sustained flight or those which fly to the best advantage if considered from an economical standpoint. The frigate bird, which is perhaps the bird of all others most at home in the air, lacks carrying capacity, being so far as mere muscle goes comparatively weak, sailing by skill and not by strength. Birds of prey, on the other hand, which can carry away a quarry of very nearly their own weight, fly when they do this by labored strokes of their powerful pinions, with an apparent expenditure of considerable power, sailing or soaring only when not encumbered by extra weight.

The albatross, which has a maximum weight of 18 pounds and a spread of wing of 11 feet 6 inches, is the most notable example we have of long sustained flight in a heavy bird,* and it is the more remarkable from the fact that as the wing is extremely narrow its area is very small, not exceeding 7 square feet. The surplus lifting power of this bird is quite small, since the wing muscles on whose area we must base our estimate of the amount of force exercised in flight are comparatively small. Both the albatross and frigate bird, however, are of double interest from the very fact of their great extent of wing and small amount of muscle, since they thus throw some light on the question of the length of wing that may be manipulated with a given force.

The condor, and his cousin, the California vulture, weigh about the same as an albatross,* but the broad, rounded shape of their wings gives them a much greater area, and this difference is, in turn, related to differences in flight, for the great vultures soar high in the air, while the albatross skims the sea, rarely rising to an elevation of 150 feet.

It is to be noted, however, that the question of food has something to do with the mode of flight, since the one bird seeks its food from the surface of the water, while the other mounts aloft to scan the earth in search of something eatable.

Humboldt is credited with having seen a condor soaring above the summit of Chimborazo; but that this or any bird ever attains such an altitude† is more than questionable, and Whymper, the most recent and most careful observer, puts the range of the great vulture at from 7,000 to 15,000 feet.



CURVE SHOWING RELATIVE DECREASE OF WING SURFACE WITH INCREASED WEIGHT OF BIRD.

The condor is said to attain a spread of wing of 15 feet, but no bird of anything like this size is preserved in any collection, and even 10 feet 6 inches from tip to tip may be looked upon as exceeding the normal or average size.‡ As the albatross averages 10 feet from tip to tip, and is said by good observers to reach 12 or even 14 feet,§ it may be pretty safely set down as having the greatest stretch of wing of any animal now living. Certainly the albatross stands first in length of wing bones, for these measure 8 feet 3 inches in the great wandering albatross, while the bones of a large condor have a combined length of but 6 feet 1 inch. Moreover, the albatross inhabits the wind-swept seas of the Southern Hemisphere, one of the stormiest regions of the globe, and is continually called upon to wield its pinions in the teeth of gales, and the successful manner in which this is done calls forth the admiration of the observer.

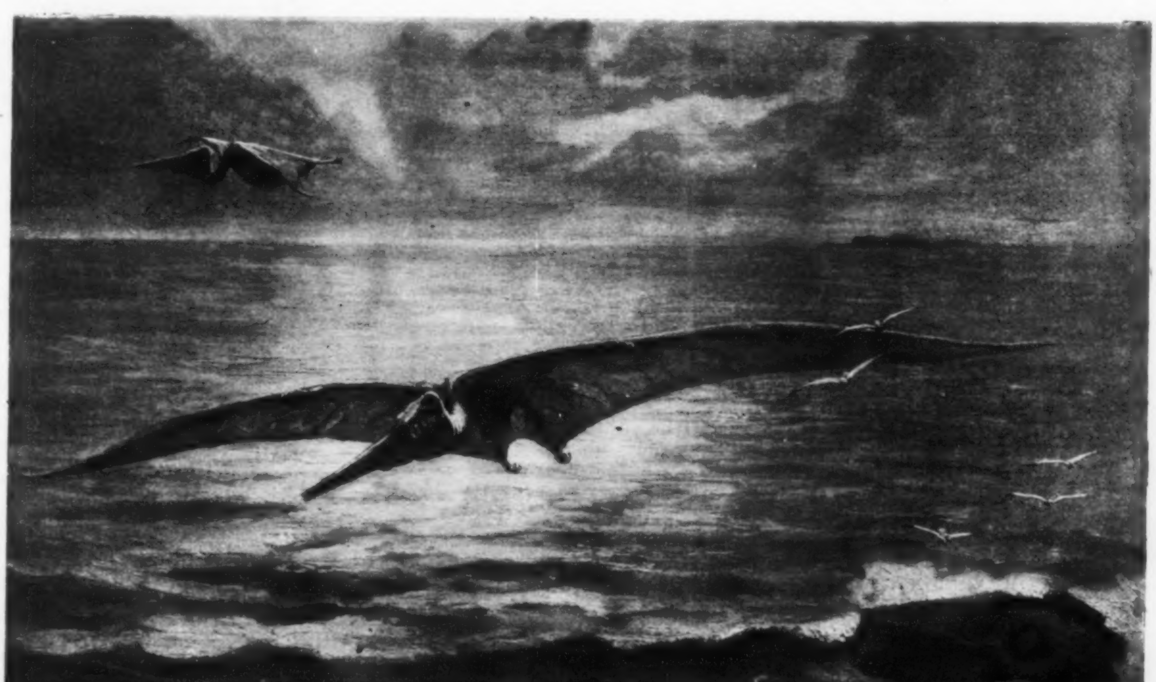
So far as carrying weight is concerned, the trumpeter swan stands at or near the head of the list, for this bird attains a weight of 28 pounds, and carries this far and fast with a spread of wing of 8 feet. Its mode of flight is entirely different from that of the albatross, being performed by powerful wing beats, while the latter bird rarely flaps its wings, but sails over the water with little apparent expenditure of muscular power. In default of these birds the wild goose (*Bernida canadensis*) and turkey buzzard may serve as representatives of differences in method and apparatus of flight.

The goose, like his relative, the swan, flies by means of the strokes of his wings and carries a weight of 9 pounds, with a wing area of 2.65 square feet and a muscle area of 8.84 square inches; the sailing buzzard, with a weight of 5 pounds, has a wing area of 5.3 square feet and a muscle area of 5.12 square inches. Thus the one bird has 0.3 square foot area of wing per pound of weight, while the other has 1.06 square feet per pound of weight. Or, if we wish to compare the area of wing to the area of sternum, we may say that in the goose this ratio is 43 to 1 and in the buzzard 149 to 1. The minimum of wing area, both positively and comparatively, is reached in the humming birds, which may be typified by a species common in Barbadoes (*Eulampis chlorolæmus*). This little bird, weighing 0.015 pound, has a wing area of 0.026 square foot, and a muscle area of 0.33 square inch, a ratio of 11.4 to 1, while, if brought up to ounces, the wing area per ounce would be but 0.76 square inch.

These differences are dwelt on at some length in the introduction to this paper, where they are graphically expressed by means of diagrams and compared with the weight, horse power, and supporting area of a flying machine.

The buzzard may be compared to a racing yacht with small hull and great spread of canvas; the humming bird, like a torpedo boat, is mainly engine.

Mammals may be practically left out of consideration in discussing large flying creatures, for while many of the bats fly with the utmost dexterity, none of them attain any considerable size, the largest of the fruit bats (*Pteropus edulis*) weighing under 3 pounds and having a spread of wing of 5 feet. Almost everyone is acquainted with the rapid fluttering flight of small bats, and it need only be said that the large species fly with measured wing beats not unlike those of a crow.



THE GREAT PTERODACTYL ORNITHOSTOMA.

Such are some of the flying forms of to-day, and, with few exceptions, they seem not to have been exceeded by any creatures of the past. *Harpagornis*, the extinct eagle of New Zealand, was larger and more powerful than any existing bird of prey, although the South American harpy eagle is a near second;* but the more notable exceptions were the great flying reptiles, or pterodactyls, which abounded on the shores of the inland sea that during Cretaceous time extended from the Gulf of Mexico up the Mississippi Valley

* Sailors sometimes catch an albatross, fasten to it a tag bearing the name of the ship, date of capture, latitude and longitude, and then release the bird. A specimen thus tagged and subsequently taken by another ship is preserved in the museum of Brown University, showing that in twelve days it had traversed a distance of at least 3,150 miles, probably more, since the albatross rarely flies in a direct line.

* A California vulture, 1 year old, in the National Zoological Park, weighed 18½ pounds.

† Birds are known to migrate at a very considerable elevation, but it is believed that none have as yet been recorded so high as 4 miles. The height of Chimborazo is 20,494 feet.

‡ A fine condor from Patagonia had a spread of only 8 feet 8 inches, and the California condor in the National Zoological Park at Washington measures but 9 feet 2½ inches across the wings. Like most large animals, condors shrink wofully before a tape line.

§ The largest of four albatrosses measured by the writer had a spread of wings of only 10 feet 3 inches, but these were birds of 1 year and 2 years old, and many of the old birds seen were certainly much larger. The ship's carpenter claimed to have measured a bird of 12 feet spread.

* A specimen of this bird, Thrasaetus harpyia, in the National Zoological Park, weighs 19½ pounds.

and northwesterly through Kansas. And as the huge dinosaurs were the largest creatures that ever walked, so the greatest of these pterodactyls were the largest creatures that ever flew, their outstretched wings having a spread of 20 feet from tip to tip.

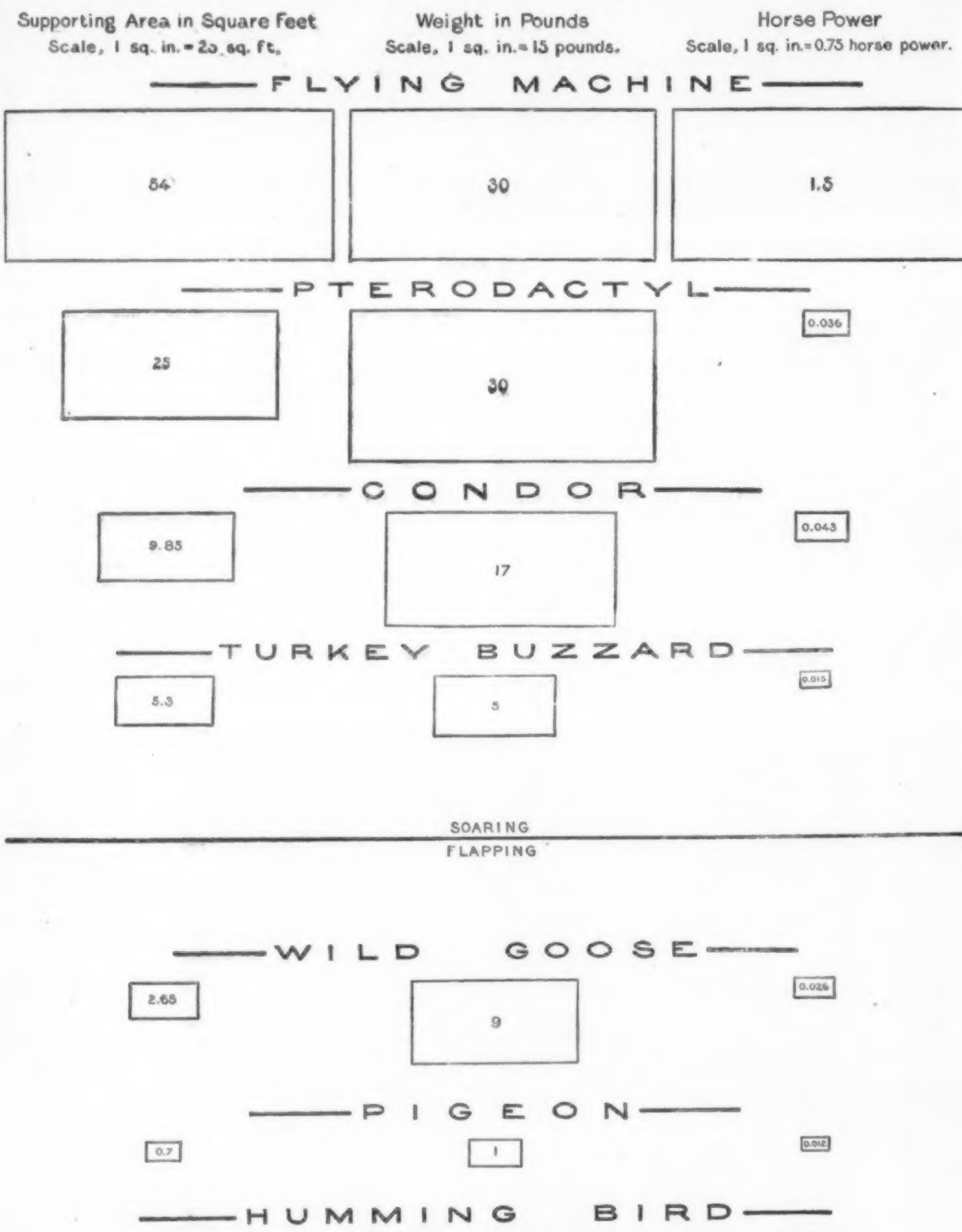
There is one possible rival, a bird supposed to be a relative of the pelicans, described by Prof. Cope under the name of *Cyphornis;* but as this bird is known from a small fragment only and its wing area very far from certain, *Cyphornis* may be ruled out of competition.

The greatest of the pterodactyls, *Ornithostoma ingens*, has been described at some length by Prof. S. W. Williston, of the State University of Kansas, and from his articles have been taken the facts relating to this curious creature that are herein embodied.

The great moa marks one extreme of specialization, the disproportionate size of the hind as compared with the fore limbs, for this big bird had legs 6 feet long and no fore legs at all; *Ornithostoma* marks the other extreme with a wing 9 feet in length and a leg so small and weak as to be of little use save for spreading the wing membrane. For, like other pterodactyls, whose wings are accurately known from their impressions in the fine-grained lithographic stone of Solenhofen, this species doubtless had a membranous wing something like that of a bat. As for the body, being that of a reptile, it must have been naked and possibly covered with small scales like those on the body of an iguana, so that on a small picture the skin would appear quite smooth. While the body was small in comparison with the extent of wing, the head, which was principally beak, was very nearly 4 feet long, extending backward to form a large but thin crest. This has a direct relation to the enormous length of the beak, since it furnished a point of attachment for muscles whose pull counterbalanced the leverage of the front part of the head. The beak was dagger-like, being very narrow, pointed, and quite toothless. Whether this beak was covered with a thin, hard skin, like the epidermis on the head of a crocodile, or with horn, like the bill of a bird, is not positively determined, but the weight of evidence is in favor of the former, since none of the pterodactyls yet found show any traces of a horny bill. In the peculiar shape of the lower, back portion of the beak there is a suggestion of the former presence of a small pouch, like that found in cormorants, and this would be in accord with the supposed fish-eating habits of *Ornithostoma*. Like other animals with long, narrow wings, *Ornithostoma* doubtless sailed somewhat after the manner of the albatross. This is inferred not only from the size and shape of the wing, but from the comparatively small size of the breastbone, to which were attached the muscles used in flight. Birds which fly by strokes of their pinions have the breastbone deeply keeled to furnish room for the attachment of the wing muscles, and the size of this keel is in direct relation to the rapidity of the wing strokes, reaching its maximum in the humming birds, in which the wings are vibrated so rapidly as to be invisible. Birds which sail have the breast muscles much reduced, and the extreme of reduction is found in the frigate bird, which, with a spread of wing of 6 feet 4 inches, has a muscular area of only 3.50 square inches.*

There is another point in the anatomy of *Ornithostoma* besides length of pinion that lends strength to the supposition that it sailed, and this is found in the structure of the fore limb. It was pointed out by Mr. Huffaker that in spite of the deficiency of muscle shown by soaring birds the support of the wing was very strongly built; thus the frigate bird with its small breastbone has the bones of the shoulder joint firmly united with one another and with the breastbone. In the albatross strength is gained by shortening and widening the bone to which the wing is directly fastened and giving it a broad base for attachment to the breastbone. In the great pterodactyls strength was obtained by bracing the shoulder blade against the backbone, thus the body, so to speak, was slung from the wings. In addition, three sections of the backbone were united in one piece in order to give a firm point of attachment, the whole arrangement curiously suggesting the fore leg of a turtle.

In spite of its great extent of wing, *Ornithostoma* was not a heavy animal, possibly not so heavy as the trumpeter swan, for the body was small and the bones reached the extremes of lightness, being far lighter than in any bird. This may be appreciated by quoting Prof. Williston's remark that the bones were almost papery in their character, one of the finger bones 26 inches long and 2 inches in diameter being no thicker than a cylinder of blotting paper. The same authority, basing his estimate on this extreme lightness of structure and the small size of the body, places the weight of one of these pterodactyls at only 25 pounds, and with this weight and its great spread of wings the creature must have flown as lightly as a butterfly. Even if we increase the estimated weight by 20 per cent, we have a creature weighing but 30 pounds, so that the body was even more an appendage to the wings than in the frigate bird, and seems to have been just heavy enough to counterbalance the weight of head and neck to insure equilibrium.



A GRAPHICAL COMPARISON OF THE FLYING MACHINE AND BIRDS.

As *Ornithostoma* was capable of long-sustained flight, and as its bones are found under conditions indicating that it went far out to sea, it is not improbable that it fed largely or entirely on fish. That they formed a part of its diet is certain, for fish bones and scales are found with the remains of pterodactyls, and it is easy to imagine this great reptile gliding over the sea, with outspread wings, snatching up fish right and left with its long beak as easily as a museum assistant picks them out of a jar of alcohol with a pair of forceps. The bird in the foreground is represented in our illustration as just turning to its right, the left wing being advanced and raised to cause the turn.

With its small body and enormous wings *Ornithostoma* may be looked upon as the king of flying creatures, and as more highly specialized than any flying animal before or since his time.

Finally, it is an interesting question as to whether or not the condor, the albatross, and the pterodactyl mark the limit of size attainable by flying creatures—are the mechanical difficulties in the way of using wings so great that evolution stops at a weight of 30 pounds and a spread of wing of 20 feet? Would animals above that size have trouble in manipulating their wings and be unable to compete with smaller and more active forms, or is it that the exigencies of life have never called for the development of a larger creature?

These are queries that may not be settled offhand, and it may only be said that the vast majority of birds are small and agile, and that, although birds and pterodactyls flew side by side over the Cretaceous seas and shores, the birds never reached the size of their reptilian associates, and, so far as we know, these mark the limit of size among flying animals.

* This is stated with some hesitancy, as no sternum of a large albatross is available, and it may be that, all things considered, the albatross has the least amount of wing muscle. The ratio of wing muscle to wing is smaller in the turkey buzzard than in the frigate bird, being, respectively, 1:125 and 1:114, this owing to the much broader wing of the buzzard. On the other hand, the great humming bird (Patagona gigas) has a ratio of muscle to wing area of 1:23, and a small species a ratio of but 1:11.39.

THE ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA, AND GEOLOGY AND GEOGRAPHY AT THE CONVENTION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.*

By EDMUND OTIS HOVEY.

THE combination of the regular annual meeting of the Geological Society of America and the meeting of the American Association for the Advancement of Science for the first time in the winter, brought together an unusually large number of geologists and those who take an interest in the science during the newly-established Convocation Week, which is the week which includes the 1st of January. The convention was held in the city of Washington, which is always a popular place with scientists. The number of papers which were presented to the combined meetings of the geologists was so large (ninety-five in all) that it will be possible to refer in this report only to a part of those that were read; and among so many good things it is difficult to make selection. On account of the conflict of the meetings of the two geological bodies, Section E of the Association held but two independent meetings, one on Monday afternoon, when five papers were read in lieu of the vice-presidential address from Dr. Orville A. Derby, retiring vice-president and chairman of the Section, whose duties as government geologist have detained him in Brazil. The other independent session was held Friday morning, when the papers pertaining to the recent eruptions in the West Indies by those geologists who went to the region last summer were read and discussed. The papers on the programme of Section E were accepted by the council of the Geological Society for reading before that body, and were merged in the programme of the Society. The officers of the Society for the meeting were Prof. N. H. Winchell, president, and Prof. H. L. Fairchild, secretary; those of Section E were Prof. W. M. Davis, chairman, and E. O. Hovey, secretary.

In his address as retiring president of the Society, Prof. Winchell discussed at length the question, "Was Man in America in the Glacial Period?" The paper reviewed the history of the Glacial period and considered the evidence Glacial man furnished by the extensive explorations carried on at Trenton, New Jersey, and elsewhere, and dwelt especially upon the discovery of human bones made at Lansing, Kansas, in the loess beds. The author's conclusion was that man inhabited America during the latter portion at least of the Glacial period. A paper read by Prof. Winchell related in brief "Some Results of the Late Minnesota Geological Survey." This paper mentioned (1) some of the scientific conclusions and (2) some of the known economic results of the Survey presented in the final report. (1) Scientific: (a) the identification of the parts of the upper Cambria. (b) The definition of the Lower Silurian. (c) The determination of the extent of the Cretaceous toward the east. (d) The definite determination of the duality of the ice epochs. (e) The determination of the duality and alternation of the ice lobes and the resultant glacial lakes. (f) The discovery of the duality and later of the triple character of the iron horizons of the Lake Superior region. (g) The separation of the Archæan into two non-conformable parts. (h) The discovery that the Animikie overlies both parts of the Archæan non-conformably. (i) The recognition of the igneous origin of the greensand of the Animikie. (j) The determination of the igneous of the jaspilytes of the Mesabi and Vermilion ages. (k) The addition of numerous minerals to the geographic area of the State. (l) The determination of the metamorphic origin of gabbro from Archæan greenstone. (m) Of granite

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

from Archæan sediments. (2) Economic and Educational: (a) Determination of the cause of foul waters in the prairie region. (b) The demonstration of the excellence of the Hinckley sandstone and its consequent wide adoption. (c) The discovery and announcement of the Mesabi iron ores. (d) The distinction of the gabbro (igneous) ores from the Mesabi iron range. (e) The delineation of the Mesabi belt as distinct from the Vermilion, which has facilitated search and exploitation. (f) The demonstration of the utility of intrusting geological surveys to the State universities.

In discussing the geographic development of western Pennsylvania and southern New York, Marius R. Campbell, of the United States Geological Survey, said that the study of the upland features of that region had satisfied him that this plateau is not so old as the deeply dissected upland of the bituminous coal field of West Virginia and Kentucky. The latter is generally regarded as of Cretaceous age; therefore the former must date back only to some part of the Tertiary epoch. The author has found evidence of a peneplain intermediate in position and age between the Schooley (Cretaceous) and the Somerville (Tertiary) peneplain. This newly-recognized feature is called the Harrisburg peneplain from its extensive development in the belt of shale hills back of that city. From whatever point this peneplain is traced it rises toward the New York line, and the author has provisionally correlated it with the general upland tops in the plateau region of northern Pennsylvania and southern New York. If this correlation is correct, the peneplain has been deformed into ellipsoidal dome-shaped structure whose major axis extends in a northeast-southwest direction, and whose maximum development is attained in Potter and McKean counties, Pennsylvania.

"The Topographic Work of the Geological Survey in Northern Canada," by Robert Bell, M.D., acting director Geological Survey Department, Ottawa, was considered. He contended that previous to the confederation of the Canadian provinces in 1867, and the subsequent acquisition by the Dominion of the other British possessions in North America, including British Columbia, the territories of the Hudson's Bay Company, the Labrador peninsula and all the islands lying north of the mainland of North America, the operations of the Canadian Geological Survey were confined to the southern parts of the areas which now constitute the provinces of Ontario and Quebec. Since confederation, however, the attention of the department has been directed to surveying these vast newly-acquired territories and the regions which have been added to Ontario and Quebec. These tracts were entirely unsurveyed, and only partially explored, the main geographical features alone being roughly indicated on the maps. The subdividing of the fertile lands of Manitoba and the Northwest Territories was performed by a different department, and their work added little to the knowledge of the topography of the country. The fieldmen of the Geological Survey have been the pioneer surveyors of the natural features of the vast regions which constitute half the continent. In order to map out the rock formations, the geologists found it necessary to make topographical and geological surveys simultaneously. From their long experience in these operations, they have been able to do this work rapidly and well, and the object of this paper was to show the astonishing amount of accurate geographical work which had been accomplished by a small number of devoted men with very limited means at their disposal.

In a paper entitled "The Blue Ridge of North Carolina," William Morris Davis, Harvard University, said in part: "The Blue Ridge in northern North Carolina and southern Virginia is not properly a ridge with strong slopes descending on either side of its crest line, but it is an escarpment separating an uneven and often mountainous upland on the northwest from a rolling and occasionally mountainous lower land on the southeast. The escarpment is not determined by variation of structure in the disordered schists in which it is carved, but by the unequal length of the rivers which drain the upland back of it on the northwest and the lower land in front of it on the southeast. The high-level head waters of the northwestern rivers, which discharge via the Mississippi into the Gulf of Mexico, are constantly losing length by the retreat of the escarpment through the retrogressive erosion of the low-level head waters of the shorter Atlantic stream. There is no local indication that the sea has had any share in producing the escarpment."

Grove K. Gilbert, of the United States Geological Survey, in treating of "Physiographic Belts in Western New York," said that the physiographic belts recognized by Lincoln could now be studied in part with the aid of contour maps. South of the Drumlin belt is a zone of great glacial erosion in which the aspect of the land was revolutionized by ice sculpture. It is limited southward by a great moraine, beyond which the upland drainage is pre-Glacial, and in which the glacial modification of hill-forms diminishes rapidly to the glacial boundary.

"Configuration of the Rock Floor of the Vicinity of New York," by William H. Hobbs, Madison, Wis. "New York city and its approaches is now the focus of engineering enterprises never before paralleled in the history of the world. The revelations afforded by these public and private undertakings are of much significance from a geological point of view, particularly, however, as regards the formation of the island and the channels surrounding it. To the data now being furnished, have been added many from earlier enterprises—the numerous bridges, tunnels, well borings, foundations, etc."

The author holds that the surface of the rock floor of Manhattan Island and vicinity and the position and relations of the bluffs bounding the island and to be found within it, with other considerations, lead to the conclusion that faulting is the principal cause of the outline and some of the configuration of the island.

J. W. Spencer, of Washington, D. C., has devoted considerable study to the charts of the oceans, and in a paper "On the Drowned Valleys Off the North Atlantic Coast" he presented a sequel to earlier studies presented to the Geological Society some years ago and published in its Bulletin for 1894. He described the subcoastal plains, which have a breadth of from 20 to 80 miles, or 300 miles off Newfoundland, reaching to a depth of 200–250 feet, with, in places, an outer terrace of 200 feet lower. Across this Lindenkohl traced the Hudson valley to a cañon nearly 3,000 feet below sea level, while the author recognizes its continuation, in the contours of the continental slope, to oceanic depths. The Chesapeake and Delaware valleys are buried on the subcoastal plains, but reappear in cirques at their margin, and can be traced to 60 miles down the continental slope where they enter a deep embayment, like the Hudson. The valleys of the Gulf of Maine and St. Lawrence, and smaller ones, are traced across the subcoastal plains into the conspicuous amphitheaters in the edge of the continental shelf, and these widen out into embayments indenting the great slope to oceanic depths. The continuation of the deep fjords of Newfoundland are obstructed, supposedly by drift, in crossing the coastal plain, but this is in agreement with the fact that the Lafayette formation is older than the great valley-making epoch, but that the Columbia formation was subsequent to it. So also the remarkable deep cirques in the far North Atlantic are described. The author considers these features, which have their analogies on the margins of the Mexican tablelands, as having been finally fashioned by atmospheric agents, in which case they become evidence of great continental elevation about the beginning of the Pleistocene period.

"Timber Lines," by Israel C. Russell, Ann Arbor, Mich. "Timber-line" as commonly defined, is the upper limit of arboreal vegetation on mountains. Its position is determined mainly by the occurrence of a mean annual temperature of about 32 degrees Fahrenheit, but locally its elevation is regulated by soil conditions, and by differences between various localities in snowfall, severity of winter storms, exposure to the sun, etc. It may with propriety be termed the "cold timber-line." Above it on high mountains, there is commonly a region occupied by alpine flowers, and still higher a region of perpetual snow. When traced from warm to colder regions, or in general from equatorial toward polar tracts, it becomes lower and lower; in North America it descends nearly to sea level in Alaska and northern Canada, where it defines the northern limit of the sub-arctic forest and becomes the "continental timber-line" to the north of which lie the barren grounds and tundras, which correspond to the zone of alpine flowers on lofty mountains in temperate latitudes.

On some of the mountain ranges of the arid portion of the United States, there is a lower limit of tree growth, the position of which is determined in the main by insufficient moisture and locally by soil conditions, including the presence of alkali, hot winds, forest fires, exposure to the sun, etc. This may be termed the "dry timber-line." Below it are treeless, grass-covered plains and valleys. On the mountains of central Idaho, the cold timber-line is sharply drawn at an elevation of about 10,000 feet, while the dry timber-line, equally well defined, has an elevation of about 7,000 feet; between the two there is a belt of forest trees which encircles the mountains. In southeastern Oregon, Nevada, southern California, etc., where the climate is excessively arid, the dry timber-line is higher than in Idaho, and in certain localities meets the cold timber-line and the mountains are bare of trees from base to summit. The dry timber-line decreases in elevation when traced from arid to humid regions. In the central part of the continental basin of North America, it defines the border of the treeless portion of the Great Plateaus and the prairie plains, and at the north coincides with the southern limit of the subarctic forest. On the borders of the treeless plateaus and the prairie plains the position of the margin of the encircling forest is determined mainly by lack of moisture, but is varied locally by soil conditions, hot winds, forest fires, etc., in the same manner that the lower limit of tree growth on the mountains of arid region is regulated.

When the humidity is sufficient for the growth of trees, as for example on the mountains of New England, the dry timber-line disappears. An arid region may be bordered at a lower elevation by a region with sufficient humidity to permit trees to grow, and may then be bordered both above and below by the dry timber-line, as is the case in southern Idaho. Where an arid region reaches sea level, as in Arizona, southern California, and the West coast of Mexico, etc., there is no forest below the arid belt, and in certain localities the dry timber-line meets the cold timber-line, and the mountains are bare of trees from sea level to summit.

There is also a third general cause which draws a limit to timber growth, namely, excessive humidity, as for example on the borders of swamps, the margins of lakes, etc. which may perhaps be termed the "wet timber-line."

"Some Shore Features on Lake Huron," by M. S. W. Jefferson, Ypsilanti, Mich. This paper reviewed the shore features, such as dunes, beaches old and new, town sites and river erosions at Kincardine, Ontario, with regard to Kincardine's position nearly 100 miles north of Gilbert's isobase line. Comparison was made with points to the south of the same line. Kincardine is regarded as possessing a lake and bar separating it from Lake Huron, modified in a manner appropriate to an uplift of the smaller lake bed to a height of about 70 feet above the great lake, with resulting elevated beaches, deeply-cut stream valleys, limited dune sand and increased river sediments.

The interest of petrographers and others concerned with the microscopical study of rocks centered about the "Quantitative Chemical-Mineralogical Classification of Igneous Rocks," which has been elaborated recently by Whitman Cross, J. P. Iddings, L. V. Pirsson, and H. S. Washington, and which was laid before the Section and the Society in a somewhat explanatory outline by the authors. The presentation of the subject embraced a statement of the needs and occasion for such a classification of igneous rocks; the principles on which it is based; the method of procedure employed to produce quantitative subdivisions of rock magmas; the method of expressing the actual mineral development (composition) and texture of the rocks; the nomenclature proposed; the proposition to establish a classification and nomenclature for use in field work, and for general geological purposes. The presentation closed with a correlation of the quantitative classification with the one in use at present.

"Dykes in the Oklahoma Panhandle," by C. A. Waldo. In this paper the author referred to the discovery of mineral dykes in the extreme northwest townships of Oklahoma Territory. This section has not been carefully mapped by the Geological Survey, and it is a region about which little has been written. The discovery of the dykes resulted from an attempt to explain the existence of extensive mineral deposits in that locality.

Volcanoes and vulcanism received considerable attention at the meeting, one entire session being devoted to the discussion of the Caribbean Islands and the recent eruptions there. Dr. J. W. Spencer, in a paper on "The Geological Age of the West Indian Volcanic Foundation," stated that his personal explorations had led him to the conclusion that the whole Caribbean plateau was underlaid by an igneous basement of pre-Tertiary age. Some of the islands show Tertiary limestones resting upon this foundation. The relations of the igneous formations to the later fossiliferous beds show that volcanic activity was renewed about the close of the Pliocene period, and it has continued intermittently to the present day.

Robert T. Hill, of the United States Geological Survey, who has devoted a great deal of time to the systematic study of the West Indies, gave a paper on "The Geologic and Physiographic History of the Lesser Antilles," in which, after reviewing the classification of the group as given in his various publications, he said in substance: Vulcanism has prevailed in the Caribbean Islands since Cretaceous time and the volcanic ejecta have consisted essentially of hornblende-andesites throughout. Physiographically the islands are of several distinct types. The Caribbee Islands proper are strictly constructional forms modified somewhat by rainfall erosion, and truncated around the edges by marine erosion. The changes of level have been more or less epeirogenic, but never, at least since Jurassic times, has there been any connection between the Windward Islands and the mainlands. There is absolutely no topographic or geologic proof that the volcanic Caribbees are of other than progressive constructional origin, or that any continent or semblance of a continent ever prevailed on their present site.

Prof. Angelo Heilprin, of Philadelphia, described the great eruptions of Mont Pelé, which took place August 24 and 30, and during which he was high up on the slopes of the volcano. The eruption of August 30 was the one which destroyed Morne Rouge. It was characterized by the same features of violent eruption that were observed during the May eruptions of the volcano, tremendous heat, dust-laden steam, showers of incandescent rocks, etc. No semblance of true flames was observed in connection with the eruptions, though the electrical phenomena were marvelous. The speaker was very fortunate in getting photographs of the summit of the mountain from the southwest after the August eruptions. These were thrown upon the screen at the meeting, and showed the new inner cone of eruption rising above the rim of the ancient encircling crater.

Prof. Israel C. Russell, of Ann Arbor, Mich., delivered an illustrated popular lecture upon the eruptions of Mont Pelé and La Soufrière before the National Geographic Society and the Association, and on West Indian day confined himself to a discussion of the principal causes of the deaths resulting from the eruptions. After reviewing the arguments presented by those who have favored the theory of an exploding hydro-carbon gas as the cause of the numerous instantaneous, or practically instantaneous, deaths, Prof. Russell gave his reasons for adhering to the view now held by most of the scientific observers of the eruptions that highly heated, dust-laden steam coming from the craters at the velocity which the blast evidently had would account for most, if not all, of the facts observed.

"Secondary Volcanic Phenomena of the West Indian Eruptions of 1902." In this paper George Carroll Curtis, of Boston, stated that over the area most seriously affected by the eruptions there lay a large amount of volcanic ejecta upon which erosive forces were rapidly working. This afforded an excellent opportunity for the study of stream development upon an initial cover. Portions of the coastal plain had subsided; other deposits had undergone elevation; tidal waves had swept the marginal slopes; and marine erosion was rapidly altering new deposits. Flows of mud-like detritus had filled the valleys and extended their deltas seaward, entombing villages and inhabitants. From the ash-filled valley floors minor eruptions were taking place, giving rise to early reports that lateral craters connected with the main source of volcanic energy had played an important part in the great eruptions. Detailed study on the actual ground of these eruptions indicates that they were not from a primary volcanic source, but that they formed a series of secondary manifestations with origin, process of outburst, and developed topography peculiar to themselves.

Edmund Otis Hovey, of the American Museum of Natural History, contributed two papers to the West Indian series. In the first he spoke of the inner cone of Mont Pelé crater and its relation to the destruction of Morne Rouge. He said in part: "The growth of the inner cone of eruption above the western vent beside Etang Sec caused the partial closing of the great gash in the side of Mont Pelé, and finally lifted the volcanic outlet above the rim of the great crater, to a point where there ceased to be any hindrance to the radial expansion of the explosions. Then the great explosion of August 30, which seems to have been heavier than the May outbursts, was not guided in a particular direction, as the earlier explosions were, and Morne Rouge received the full fury of the blast. The cone grew from the level of Etang Sec, about 2,400 feet above tide, to considerably more than 4,000 feet above the tide by the middle of August. In the second paper Mr. Hovey described some erosion phe-

nomena on Mont Pelé and La Soufrière. His lantern slides showed that the stripping of the volcanoes of all vegetation by the eruptions, and the deposit of fresh fragmental material over the whole, have given opportunity for observation of the development of new erosion forms (particularly dendritic drainage) on the old surfaces.

(To be continued.)

NEW METHOD OF DAM CONSTRUCTION.*

DAM PROPOSED AT OCHOA, ON THE NICARAGUA CANAL.

By J. FRANCIS LE BARON, C.E.

THE writer believes that a masonry or monolithic dam would be highly objectionable, either at Panama or Nicaragua, on account of the great damage that might be done to it in a few moments by an earthquake, and which might require several years to repair, and in the meantime the canal would be closed.

Any method of construction which can be substituted, which will be free from this danger, and which is at the same time a safe and practical plan should be considered attentively and welcomed gladly.

The plan recommended by the Advisory Board of Consulting Engineers to the Canal Company was for a looserock dam, 30 feet wide on the crest and 500 feet on the base, with up-stream slopes of 1 to 1 and down-stream slopes of 4 to 1, and a total height of 70 feet. This was increased by the First United States Canal Commission to 950 feet on the base, up-stream slope 1 to 1, down-stream slope 10 to 1 at the toe, increasing to 4 to 1 at the crest, with a width of 20 feet, and this rock fill was to be backed on the up-stream side by an earth, gravel, and chip backing, 20 feet on the crest and having an up-stream slope of 5 to 1, with a base of 340 feet.

The writer proposes a looserock dam, inclosed in a heavy chain-cable net, with a base of 360 feet, a crest of 10 feet, an up-stream slope of 1 to 1, and a down-stream slope of 4 to 1, as shown in Fig. 2.

The chain composing the net would consist of 1-inch ship's cable, forming meshes 3 feet square. These meshes would be crossed by two ¼-inch cable chains making four meshes of 18 inches square, all to be linked together securely by split links or shackles at

It would be perfectly safe as a weir; an earthquake would only serve to consolidate it and fill up the voids, and it could not slide or be overturned. The rock would be that taken out of the canal prism, which would otherwise be wasted.

The First United States Commission, of which the late Gen. Ludlow was chairman, did not consider impracticable the building of a looserock dam at Ochoa, with the modifications that they proposed. The chief danger that they anticipated lay in broaching the crest of the dam by the deep over-rush of flood waters. This is evidently impossible when the rock is confined in a chain-cable net, with the links of the cable 1 inch in diameter. In suggesting this dam for the consideration of the Society, it is with no desire to criticise the able Commission or their engineers, but solely for the purpose of examining all sides, as would seem desirable and proper in a work of this magnitude and importance, before deciding definitely upon a route. Even in the event of the Nicaragua route being selected, it could be greatly improved, straightened and reduced in cost, between the San Francisco hills and Serapiqui Ridge, by continuing the curve a few more stations at San Francisco, and running more to the north and further from the river in a direct line to Caño Sucio. This would do away with three curves, two of which are reversed curves of very short radius for a canal, i.e., 3,820 feet, and would substitute a tangent 6 miles long for the crooked and expensive line recommended by the Commission. It would be nearly all in swamp, and would eliminate the heaviest cut, 230 feet in depth, on the Commissioners' line, namely, that at Tamborcito Hill. The writer knows this because he surveyed the line in 1888.

A dam of this character is not a wholly untried experiment. Many years ago the writer built a small dam similar to this, but the net was made of twine, and sand bags were substituted in place of rock, it being intended to serve a temporary purpose. In this case, for the base, a cross-trench was dug with shovels, and the dam was first built up of sand bags alone. These were washed off, however, and then the writer conceived the idea of enveloping the whole dam in a net. An old fish net was pressed into service, and the dam was rebuilt and enveloped in it. There was no further trouble; the dam stood and resisted a pressure

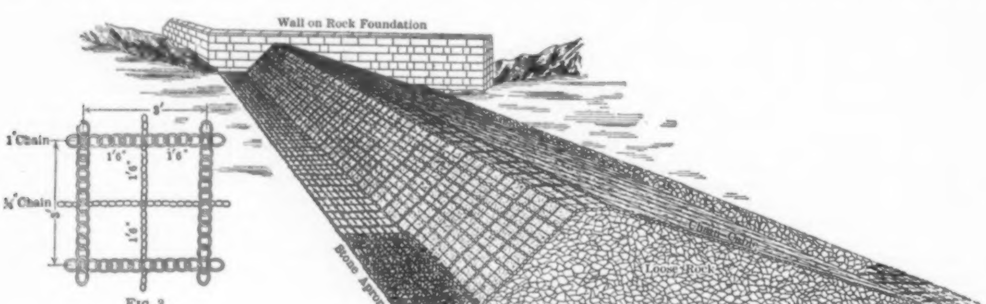
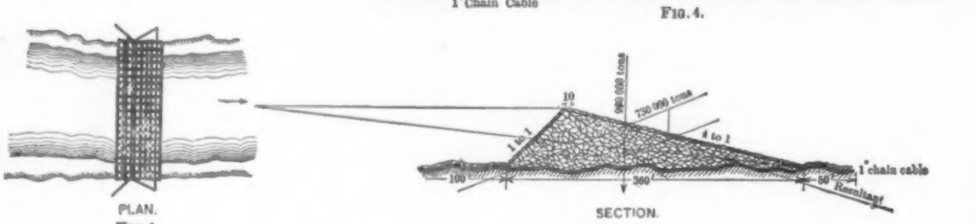


FIG. 3. FIG. 4.



PLAN. FIG. 1. SECTION. FIG. 2

NEW METHOD OF DAM CONSTRUCTION.

the crossings, as shown in Fig. 3. This net would first be laid flat on the river bottom (Fig. 1), from shore to shore, and extending up the banks to the top of the dam, and up stream and down stream above and below the dam a sufficient distance, so that, when the dam is built to its full height, the ends from the top and bottom can be brought up and fastened together on the top of the dam.

The net would also be continued on the bottom of the river, above and below the dam, as an apron, 100 feet at each end, laid flat on the bottom of the river and covered with about 2 to 3 feet of rock (Fig. 4). This chain net would accommodate itself to the inequalities of the bottom of the river, and would promptly sink into and fill any holes formed by scouring. As the dam settled from this cause, stone would be added on the top until a condition of stable equilibrium was secured. The chain net would give cohesiveness and stability to the structure, which would thus be made a unit. The bed should first be dredged out as deep as it could be conveniently.

To prevent the dam being broached during construction the net would be brought up on the down-stream slope from time to time to keep pace with the growth of the mound, and, being securely linked to the sides and front ends as the work progressed, would effectually prevent the degradation of the crest, no matter what depth of water was passing over.

This method of construction would present no difficulties, and the structure when completed would present no conditions that could not be readily computed. As the work progressed, sufficient broken stone and gravel would be thrown in to fill all voids of the dam, and after its completion more gravel, sand and clay would be thrown in on the upper side to make it watertight. This material would be sucked in among the loose rocks by the current. Wing trenches in the banks would first be excavated to rock or carried to solid masonry flanks, and these trenches filled with the chain net, and the enveloped rock would be in turn linked to the main dam.

The cost of such a dam would be far less than that of a masonry dam, and could be built in half the time.

* Proceedings of the American Society of Civil Engineers.

of about 9 feet and a flood of 18 inches over the crest.

Suppose the stream had a velocity of 6 feet per second and a depth of 15 feet over the top of the dam, conditions that probably will never be exceeded; also, suppose a mahogany log, 20 feet in diameter and 60 feet long, should be brought by the current end on against the dam; assume that this log would have the same velocity as the stream, viz., 6 feet per second, and that its weight would be 942,480 pounds ÷ 2,000 = 471 tons.

The strain of a force pressing against the center of the net would be transmitted in one-quarter ratio from link to link of the chain to the ends of the net or to some point where the net is immovably held by projecting rock or to a corner or sharp edge that holds the net immovable. The strains thus transmitted in all directions would be modified more or less by the friction of the chain net on the rocks, or by its partial fixation by sharp projections which would not prove actually immovable. The strains would also be transmitted by pressure through the rock mass of the dam to the chains on the opposite sides and ends. The amount of these transmitted strains would be modified by the solidity of the rock mass and its stability, for it is plain that if the rock mass were perfectly immovable no strains would be transmitted to the opposite chains, but, in the case of a loose rock-fill dam, the pieces of rock composing it would have a certain freedom of motion over each other, and those on the crest would be likely to be pushed over and off the crest by a sufficient force, if not withheld by the cables.

The forces tending to produce this result would be the impact and lifting force of the water applied along the whole crest of the dam, and the force produced by the impact of any large body, such as a log floating with the current. The net being divided into squares by 1 inch chains, and these again into four smaller squares, by ¼-inch chains, those squares against which the moving body impinged would be called upon to sustain all the strain, provided the adjoining squares to which they were connected were held rigidly; but this not being the case, the strain would be transmitted to the next square and the next, and so on, each square resisting a certain amount in proportion to the friction of that particular square on the loose rock on which it was lying, which friction would be greatly modified by the projecting corners of rock within each square. In other words, if the chain net were simply suspended vertically across the river entirely free from the dam, the strains would be transmitted equally in all directions to the ends. The question then resolves itself into the friction of a heavy chain net on a rough bed of loose rock, each piece averaging, say, 100 pounds in weight, and being more or less firmly fixed in its bed by the adjacent rocks of different sizes. In the absence of any experiments as to the amount of such friction it can only be assumed that it would increase in direct proportion to the distance from the point of application of the force. It is evident, then, that at a distance, x, from the point of application, the friction would absorb all the strains, and that part of the chain lying beyond would be unstrained. This distance would depend upon the roughness of the bed, and the amount and character of the bends in the line of strain. If this distance were short a certain proportion of the strain would be transmitted around the ends or faces of the dam, and would be taken up by the chain on those sides or ends. This would also be modified by the weight of the chain. In order to broach this dam, then, the power must be able to overcome: (1) The total weight of the chain lying on the crest and on the up-stream and down-stream sides; (2) the friction of the chain on the up-stream and down-stream sides of the dam and the crest, supposing the bottom to be immovable; (3) the tensile strength of the chain; (4) the inertia of the loose rock on the crest and as low down as the power is applied; (5) the friction of the loose rock pieces on each other; (6) the friction of the chain links on each other.

Owing to its construction, the chain would not present a rigid resistance until all the links were set up to a hard bearing. Thus it would act as a cushion and would reduce greatly the effective force of the blow. The imparting force would first have to overcome the weight of the chain and its friction on the rock and on itself to draw it taut. Therefore, if 6 feet of water should be flowing over the dam, at a velocity of 6 feet per second, and if a mahogany log, 20 feet in diameter and 60 feet long, submerged 16 feet deep, should strike the dam, the strength of the dam would be more than double the broaching force, even after allowing the chain a working strength of only 5 per cent of the proof test. The friction of the chain on the rock is found by calculation to be four times greater than the whole force of the water and the log tending to overturn it; therefore the dam could not be deformed, but must remain a unit, and preserve its normal section.

Now, suppose the water to be running 15 feet deep over the dam, and assume the mean direction of the current to be elevated 22 deg. 30 min. above the horizontal, and, disregarding the weight of the upper apron, which, however, will be firmly chained to the dam, and will exert a downward pull of 19,136 tons against any force tending to overturn the dam; then, constructing the parallelogram of forces, it is found that the resultant strikes inside the base, the ratio being 65:220, therefore the dam cannot be overturned; and the angle of the resultant is less than the angle of friction, therefore it cannot slide, even if it were not prevented by the earth walls of the trench in which it is embedded, and by the method of construction by which it is anchored firmly by the chains to the flanking walls.

OIL AS FUEL IN WARSHIPS.

IN our last impression we gave an abstract of the report of the board appointed by Admiral Melville, as Chief Engineer of the United States Navy, to acquire information concerning the possibility of substituting oil for coal as a fuel in ships of war. At that time we had not the full text of the report before us; since we have, by the courtesy of Admiral Melville, received an advance copy of the annual report to the Secretary of the Navy, which contains, *inter alia*, the report of the Oil Fuel Board, and we are now able to give drawings of the Hohenstein boiler and of the various burners tried.

As a preliminary to the report we have an introduction which is really an admirable treatise on liquid fuel for naval purposes, written by Lieut. Ward Winchell, of the United States Navy. The treatise and the results of the experiments ought to go far to assign oil its proper place as a fuel. The first matter to be decided is the reason why oil ought to supersede coal if such a reason exists. It has long been held that oil must be better than coal, because it represents, ton for ton, more energy. It is not necessary to add further reasons in detail, such as the reduction in the number of firemen, in the dead weight carried, and so forth. Lieut. Winchell makes short work of exaggerated claims. He admits without question that any fuel installation which will obviate the smoke nuisance, reduce the complement in the fire room, extend the steaming radius of war vessels, and permit maximum speed to be attained at short notice, increases the efficiency and value of a fighting ship. For forty years attempts have been made to burn oil successfully. There are, in the Bureau of Steam Engineering at Washington, over 2,000 drawings and specifications pertaining to the use of liquid fuel, and it is said that new patents are being applied for at the rate of thirty a week. It is evident therefore, that if success has not been attained it is not from lack of effort. Lieut. Winchell holds that failure hitherto has resulted because attempts were made to burn the oil without properly pulverizing it. He states a fact which will be new, we think, to many people, namely, that there are dozens of burners in existence which will deal quite satisfactorily with moderate quantities of oil. The difficulty lies not in burning oil, but in burning enough of it under forced draught; that is to say, up to the present it has not been found practicable to make as much steam out of any given boiler with oil as with coal. In fact, it is highly probable a special type of boiler will have to be designed to utilize oil. It is well, we think, to bear these facts in mind. Arrangements which may answer very well indeed in a merchant steamer may, and probably will, prove wholly unsatisfactory in a

warship. In a vessel of the first kind there is no necessity to force the boilers; in one of the second kind it is essential that the boilers may be forced with perfect success, reasonable economy of fuel, and no issuing of black smoke or flame from the funnels. Lieut. Winchell holds that no approach to a contenting result can be got unless the oil is thoroughly atomized or broken up into a very fine spray. A favorite device with some inventors has been the gasifying of the oil; a special burner being provided in which the oil is preheated to a high temperature before it reaches the delivery nozzle. The plan has been very successfully carried out in the locomobile type of steam car, but only with the extremely volatile liquid known as petroleum spirit or petrol. The crude oil has, however, hitherto resisted all attempts to gasify it completely, and recourse must be had to pulverization. We explained last week that there are four methods of spraying, and we need not detail them here. As more time, talent, and money are now being devoted to the solution of the problems involved, the hope that success will ultimately be attained is strengthened. "Many unreliable statements," writes Lieut. Winchell, "have been published as to the success secured, but careful investigation shows that they were inspired by interested parties. It can be well understood that it is exceedingly difficult to secure reliable data at the present time. The several shipowners, manufacturers, and inventors are not inclined to tell of all their disappointments, reverses, or failures. Those who have attained success as a result of experiment and experience do not feel called upon to give the world information that has been obtained at considerable cost and trouble."

The Bureau of Steam Engineering, before beginning its own investigation, endeavored to obtain as much information as possible concerning what had already been done on the Atlantic and Pacific. Four large steamers were examined. In one of these the results were wholly inconclusive, as the apparatus was incomplete, and the oil, not being strained, the atomizers choked from time to time. With another ship the results were, it seems, fairly satisfactory. On the whole, this portion of the report is disappointing. Evidently they have not made nearly so much progress at the other side of the Atlantic as has been made here.

Lieut. Winchell considers at some length the military aspect of the question. He says, in this connection, as regards the question of supply, it may be more expensive if not difficult to transport and to store oil than coal. The fumes of all petroleum compounds have great searching qualities, and therefore extreme precaution will have to be taken to guard the storage tanks. If it be true that for military purposes it is best in time of war to keep all reserve fuel afloat, then liquid fuel is at a disadvantage in this respect. The mining and railroad companies have invested so heavily in the coal industry, and the transportation facilities have been so perfected, that it is now possible to deliver quickly a cargo of coal at any point in the world. There has been, likewise, a development in the method of loading and unloading cargoes of coal. Since it will require progressive development to perfect the transportation and the storage of oil, and as the world's supply is still an unknown quantity, it will be some time before there may be a reserve supply of oil at the principal seaports. It must also be remembered, when considering the problem of supply, that the naval vessel must be kept in readiness for orders to proceed at any time to any port within her steaming radius. The merchant vessel steams between regular seaports, where it would not be difficult to induce merchants to keep a supply of oil as soon as there is a regular and constant demand for it. The question of supply for battleships and cruisers may therefore not only be a commercial affair, but prove to be a military problem, since the oil requirements of naval vessels for service conditions might only be met by the government establishing oil-fuel stations. The military aspect of the question may prove to be a serious problem, since it not only necessitates heavy expenditures, but it may involve the greater question as to the wisdom of maintaining a complete chain of fuel stations between country and colony.

For a further elucidation of the difficulties to be overcome we may refer our readers to our last impression.

The Bureau of Steam Engineering acknowledges its indebtedness to the Oil City Boiler Works Company. That company, believing that in the Hohenstein boiler it had secured a steam generator suitable for naval purposes, offered to construct a marine boiler and place it at the disposal of the Bureau for experiment. A boiler room was accordingly fitted up precisely like the boiler room in the cruiser "Denver," and in this the boiler was placed and worked under forced draught for several months. When it was decided to try oil fuel, the owners of the boiler left it for that purpose in the hands of the Bureau. With coal the boiler gave the utmost satisfaction.

The Hohenstein boiler, as fitted for burning oil, is shown in Fig. 1. The following are the most important dimensions:

BOILER DATA.

Drums at water-surface level: One front drum, 24

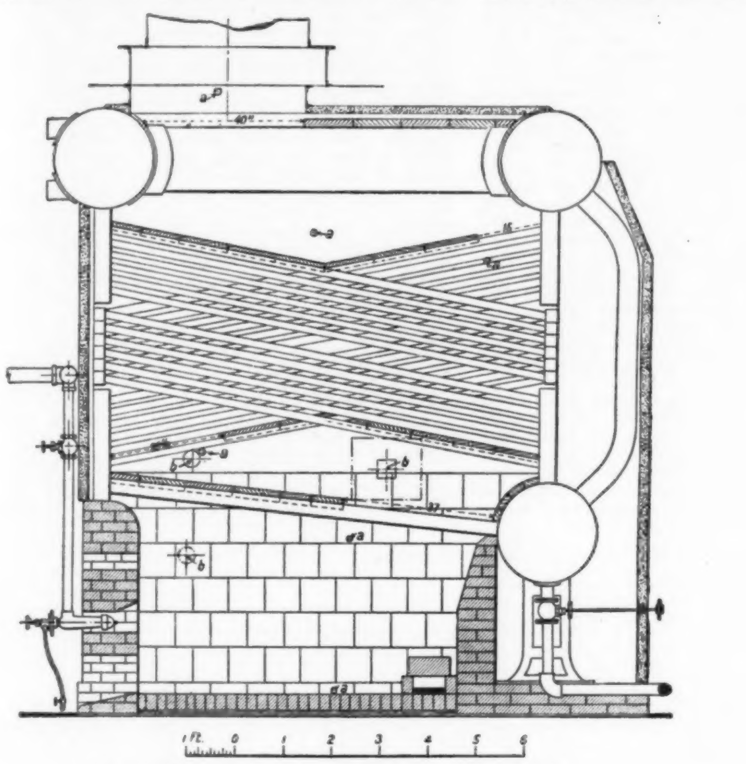


Fig. 1—HOHENSTEIN BOILER FITTED FOR OIL BURNING

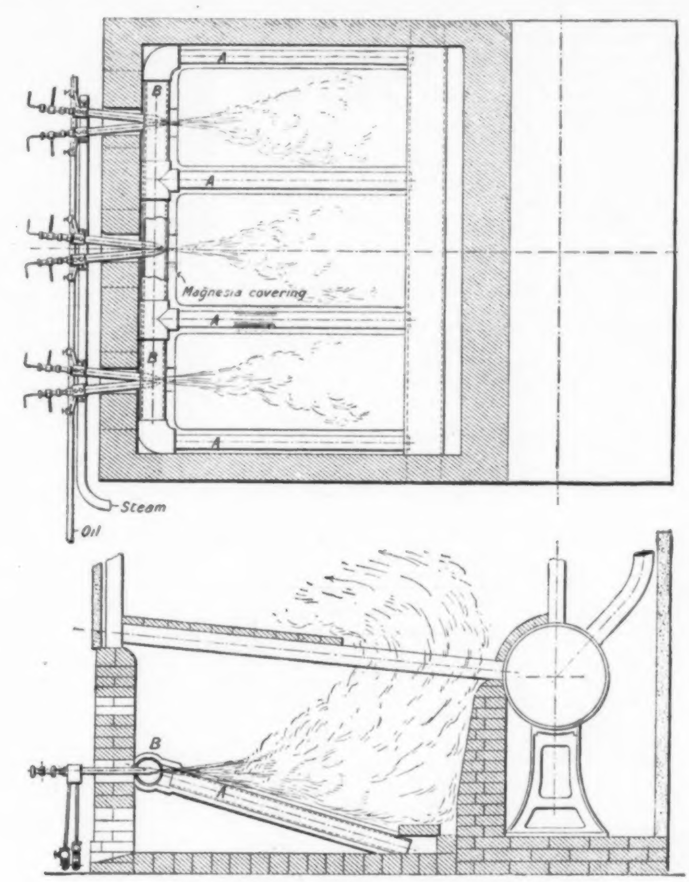


Fig. 2—INSTALLATION OF HAYES BURNERS

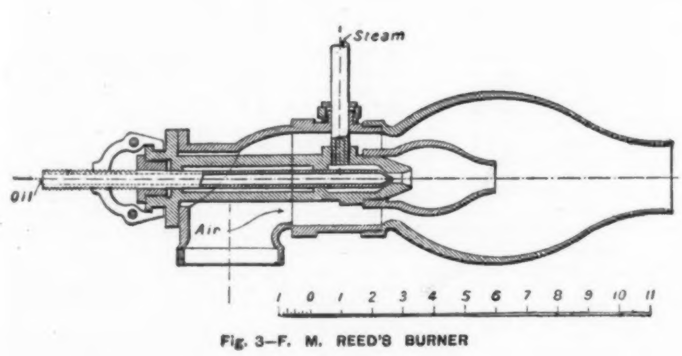


Fig. 3—F. M. REED'S BURNER

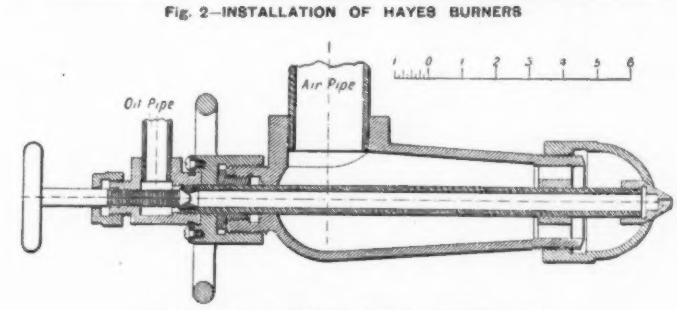


Fig. 4—OIL CITY BOILER WORKS, BURNER No. 1

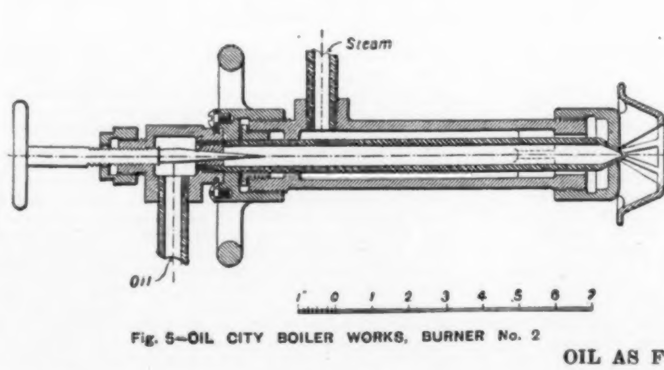


Fig. 5—OIL CITY BOILER WORKS, BURNER No. 2

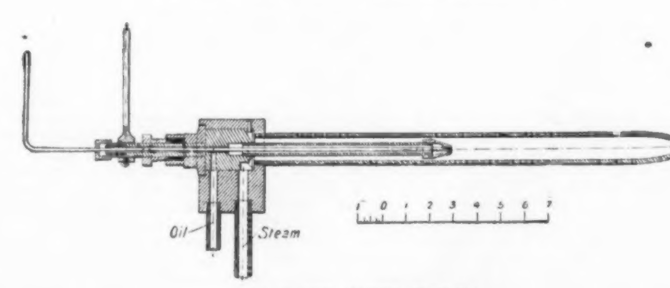


Fig. 6—THE HAYES BURNER

OIL AS FUEL IN WARSHIPS.

inches diameter (inside); one rear drum, 24 inches diameter; four connecting drums, 16 inches diameter.

One lower rear mud drum, 24 inches diameter.

Tube-heating surface: 384 2-inch tubes 9 feet long; 16 4-inch tubes 9 feet long.

15 downtake tubes 5 inches diameter.

Floor space occupied, 9 feet wide, 10 feet 11¼ inches deep.

Height above floor line, 12 feet ¾ inch.

Height over all, 12 feet 6¾ inches.

Heating surface: 2,174. Per cent water-heating surface, 100.

Grate surface: 50.14 square feet, 6 feet 4 inches long, 7 feet 11 inches wide.

Ratio of heating surface to grate surface: 43.4 to 1.

Volume of water at steaming level, 142 cubic feet.

Volume of steam space, 50 cubic feet.

Area of steam liberating surface, 75 square feet.

Weight of water at steaming level and 275 pounds pressure, 7,559 pounds.

Weight of boiler and fittings, excluding uptake and smoke pipe: Without water, 46,568 pounds; with water, 54,127 pounds. With water per square foot of grate surface, 1,080 pounds.

Height of furnace, 2 feet 5 inches.

Volume of furnace above bars, 121.14 cubic feet.

Width of air space between grate bars: ⅝-inch for tests No. 1 to No. 11 inclusive; ½-inch for tests No. 12 to No. 17, inclusive.

Ratio of grate area to area of air space: 1⅛:⅝ = 1:0.555.

Height of smoke-pipe above grate, 70 feet.

Area of smoke-pipe, 8.73 square feet.

Ratio of smoke-pipe area to grate area, 1:5.75.

Number of fire doors, 3.

A most noteworthy feature of the boiler is the arrangement of the tubes in pairs in such a way that each tube is free to expand independently of other tubes, thus effectually preventing longitudinal stresses in them. Attention is called to the fact that the entire down flow takes place within tubes which are situated in a comparatively cool place, while, on the other hand, there is invariably an upward trend to the current in all tubes and headers exposed to the hot gases. It is therefore highly probable that there are no reverse currents at any part of the water circuit, and the cross section areas of tubes and headers are equitably apportioned with a corresponding degree of certainty. The feed-water is introduced at the top of the downtake tubes, which is obviously the best possible place as regards influence on the circulation; at the same time the head due the velocity of the feed-water is conserved by means of injector nozzles pointing in the direction of flow.

It is not necessary to give in detail a description of the arrangements for testing; it must suffice to say that they were carried out with all that attention to essentials for which the officers of the engineering branch of the United States navy are celebrated.

It is worth notice that only one source of oil was available. Many offers were made of free oil, but the date of delivery was in all cases uncertain. The Standard Oil Company supplied what is known as "Beaumont crude oil." The analysis gives C 84.60, H 10.90, S 1.63, and O 2.87. Its calorific value is given as 19,081 B. T. U. The temperatures in the base of the stack were remarkably free from the rapid fluctuations that characterized the coal-burning trials. There was no flaming in the stack except during the last two hours of the eighth test, and even then the fluctuations of temperature were absent. This was a test where everything was forced to the utmost, and, therefore, unusual conditions prevailed. The stack temperatures were noted by a Tagliabue mercury-nitrogen thermometer. It was used without mishap throughout the series of trials. Advantage was taken of the constancy of the stack temperature to check the readings of a Brown quick-reading pyrometer. The pyrometer was afterward used in the furnace and elsewhere to record temperatures that were not excessive. For temperatures higher than 1,600 deg. F. a platinum-rhodium electric pyrometer was used. The measurements secured with this instrument show a maximum furnace temperature of 2,200 deg. F. for both natural and forced draught conditions. The draught pressures were measured at the same points as in the series of coal-burning tests.

As an aid to the proper regulation of the supply of oil and air to the burners, a mirror was so placed that the man in charge of the fire room could quickly note the color of the gases that issued from the top of the stack. The Board considered it of great importance that those operating an oil fuel installation should possess some device whereby the condition of affairs at the top of the stack can be immediately ascertained. After considerable study and discussion it was decided that it would be best to give each burner an excess of oil, and this would be shown by the smoke issuing from the stack. Then there was a gradual reduction of the quality of the oil until just a faint trace of smoke could be noticed. Provision was made for introducing extra air at the sides of the furnace. Holes were cut 8 inches by 1½ inches through the side walls, on a level with the furnace floor and close to its back wall. A flue was built of loose fire brick across the furnace floor, thus connecting the two openings. The roof of the flue had openings between the bricks, thus permitting extra air to be introduced where the combustion was most intense. This extra air supply was cut off during the natural draught and maximum forced-draught trials. The aggregate area of all openings for the admission of atmospheric air into the furnace is given in the detailed report of each trial.

As the Board wanted to know how much steam was wanted for atomizing, a small subsidiary boiler was fitted up to supply steam for the purpose. As a rule, it was found that the higher the atomizing pressure the greater was the amount of water evaporated. The average quantity of steam needed was 4.5 per cent of the entire evaporation.

We have now to deal with the burners used. Two of these were designed in the Oil City Boiler Works. They are illustrated by Figs. 4 and 5. The first was used during seven general tests that were intended to show whether more steam could be got out of the boiler with oil than coal. Six of these burners placed 18 inches apart were ranged across the front of the furnace in pairs, each two of a pair pointing slightly toward each other, so that the jets could coalesce about the mid length of the grate. Air for atomizing was supplied by a Root blower at pressures varying from 0.7 pound to 4.68 pounds per square inch. No description is given of the burner, but the construction will be readily understood from the engravings. Figs. 2 and 6 show the Hayes hydrocarbon burner. Part of the air supply was introduced through the back wall. The burners project through the pipe, *B*, and it is contended that the hot air in the pipe will completely gasify the oil before it reaches the burner orifices. Heating air was a direct benefit, but further experiments are needed to give its true value. The fourth burner tried is shown in Fig. 3. It is the Reed combined steam and air burner. It was found that although the burner was efficient, it required a very large amount of steam for spraying, nearly one pound for each pound of oil, and it has not met with the approval of the Board. In Fig. 1, *a* shows draught gage connections, and *b* mica windows.

Much more might be said about the report, but it would only interest those who are actually concerned in fitting ships with oil-burning apparatus. We have placed our readers in possession of the more important features of the investigation, and as a specimen of the way in which the work was done, we take at random from the tests the tabular statement above.—Engineer.

TEST OF OIL FUEL IN A HOHENSTEIN WATER TUBE MARINE BOILER, JUNE 27, 1902.

(Three hours' duration, with forced draught, using air burners.)

Time.	Steam pressure by gage.	Temperature of feed water.	Calorimeter. Higher temperature.	Calorimeter. Lower temperature.	Calorimeter. Quality of steam.	Height of water in gage glass.	Temperature. Outside air.	Temperature. Air in fire room.	Temperature. Gases at base of stack	Temperature. Air from Root blower.	Air from Root blower, pressure per square inch.	Draft pressures in inches of water. Fire room.	Draft. Furnace.	Draft. Combustion chamber.	Draft. Tube chamber.	Draft. Base of stack.	Flue gases. CO_2.	Flue gases. O.	Flue gases. CO.	Oil. Burned per hour.	Oil. Total weight burned.	Water. Fed per hour.	Water. Total weight fed.
	lb.	deg. F.	deg. F.	deg. F.		in.	deg. F	deg. F.	deg. F.	deg. F.	lb.						p.c	p.c.	p.c.	lb.	lb.	lb.	lb
10 a. m.	275	128	402	298	0.980	2	—	102	—	116	3.65	3.20	2.75	2	1.25	−0.35	—	—	—	0	0	0	0
10.15 a. m.	275	122	402	298	.980	1.75	80	103	760	119	3.65	3.20	2.75	2.10	1.25	— .35	6.7	11.5	0.5	—	—	—	—
10.30 a. m.	275	120	402	300	.981	2	—	106	—	120	3.65	3.20	2.75	2.10	1.25	— .35	—	—	—	—	—	—	—
10.45 a. m.	275	118	402	300	.981	2	—	108	785	121	3.41	3.20	2.75	2	1.25	— .35	6.9	11	.2	—	—	—	—
11 a. m.	275	116	402	300	.982	2.5	—	106	—	121	3.29	3.20	2.75	2.10	1.25	— .35	—	—	—	2,685	2,685	27,844	27,844
11.15 a. m.	275	118	402	300	.981	2	82	107	835	122	3.16	3.20	2.75	2	1.25	— .35	7.5	10.3	.2	—	—	—	—
11.30 a. m.	275	118	402	300	.981	2	—	108	—	122	3.29	3.20	2.75	2	1.25	— .35	—	—	—	—	—	—	—
11.45 a. m.	275	118	402	298	.980	1.75	—	109	875	122	3.29	3.20	2.50	2	1.25	— .40	8.1	9.8	.4	—	—	—	—
12 m.	275	120	402	298	.981	2	—	110	—	123	3.16	3.20	2.40	2	1.25	— .45	—	—	—	2,846	5,531	29,388	57,232
12.15 p. m.	275	118	402	300	.982	2	82	111	917	124	3.10	3.20	2.40	2	1.25	— .50	8	9.7	.2	—	—	—	—
12.30 p. m.	275	116	402	300	.981	2	—	111	—	124	3.16	3.30	2.40	2	1.25	— .50	—	—	—	—	—	—	—
12.45 p. m.	275	118	402	300	.981	1.75	—	111	950	126	3.41	3.40	2.40	2	1.25	— .50	7.7	10.1	.2	—	—	—	—
1 p. m.	275	118	402	300	.982	2	—	111	—	126	3.65	3.50	2.40	2	1.25	— .50	—	—	—	3,071	8,602	31,372	88,604
Average	275	119	—	—	.981	—	81	108	854	122	3.37	3.25	2.60	2.02	1.25	— .41	7.5	10.4	.3	2,867	—	29,535	—

State of weather, bright sun, few clouds.
Barometer at noon, 29.94 inches.
Kind of fuel, Beaumont oil.
Revolutions of fan blower, 483 per minute.
Revolutions of Root blower, 219 per minute.
Draft openings into furnace, 666 square inches.

11.20 A. M.—Where the smoke is densest near the stack, it has a peculiar pale blue tint different from the smoke from a coal fire. It is the color of the smoke as seen against the dark background of the smoke itself—i. e., it is the color by reflected light. The phenomenon suggests that the particles of soot are much finer than in the smoke from coal. Generally the smoke is more like that from a coal fire.

11.43 A. M.—A pane of glass (south-west window), weakened by the direct radiations from a large red hot area of the casing about 3 feet away, blew out. A board was placed over the opening within fifteen seconds. About one-third of the casing opposite the combustion chamber on the southwest side of the boiler is red hot. Six bricks, fallen from the second baffle, lie on the floor of the combustion chamber. The Root blower engine crank pin got smoking hot and a stream of water had to be played on it during the second half of the test. Water leaked from the feed stop valve, but was caught in a pail and returned to the feed tank.

1 P. M., end of test.—There is very little caked carbon on the walls of the furnace. The second baffle is badly damaged. Average smoke during the test, 2-5 by Ringelmann charts. As the test progressed, the amount of smoke gradually increased from 1 to 4, due, doubtless, to the short-circuiting of the hot gases through the damaged baffle.

BOTANY BAY.

BOTANY BAY, concerning the locality and characteristics of which such numerous misconceptions exist, is a shallow harbor, some five miles in length and six miles in width, lying about fourteen miles from Sydney, with which it has recently been connected by tramway, at the opening of which the State Premier, Sir John See, said the shores of the harbor formed the classic ground of Australia. It was at La Perouse, on the northern shore, and at Kurnell, on the opposite side, that two of the most notable events in the early history of Australia took place. On April 28, 1770, Captain Cook entered the bay, and cast anchor. The natives, who seemed to have been a manly race, were disposed to resent the intrusion of the great navigator into their quiet haven, and threatened to oppose his landing, being, unlike other savage people under similar circumstances, neither excited by the appearance of the great ship, nor terrified by the superior numbers of the strangers. Captain Cook examined the bay very carefully in the ship's pinnace, and landed several times, and his company were therefore the first Europeans to tread on the Pacific coast of the Australian continent. Before leaving the bay he performed the interesting ceremony of hoisting the Union Jack—first on the southern shore and again near the North Head—and took possession of the newly-discovered territory in the name and on behalf of the British Crown. During Cook's stay his crew had to perform the sad duty of burying a comrade named Forby Sutherland, who was in all probability the first British subject whose body was committed to Australian soil. The parish of Sutherland, which skirts the southern shores of the bay, rescues from oblivion the name of the sailor, and the two rivers—Cook and George—running into the bay commemorate the captain of the ship and King in whose service he sailed. Captain Cook was greatly taken with the possibilities of the shores of the bay as a place for settlement, and the botanists of the expedition were extremely gratified at the large variety of new plants they obtained, and the satisfaction of all parties was expressed by the name with which the bay was formally invested. The favorable report which Captain Cook made of the bay when he reached England directed attention to the possibility of founding a settlement in Australia, and when, some 17 years later, it was decided to establish a colony, it was to Botany Bay that the fleet was ordered to proceed. The proximity of Botany to Port Jackson, now better known as Sydney Harbor, destroyed its chance of being the first place of settlement, for Captain Phillip, when he had examined Port Jackson, could no longer doubt which was the more suitable site. It was while Captain Phillip's vessels were in the bay that an event happened which led to the name of La Perouse being given to a spot on the northern shore. The French government had fitted out an expedition in the interests of science and geographical discovery, and had given the command of the two ships forming the expedition to Count de la Perouse. According to the law of nations vessels equipped in the interests of discovery are exempt from interference, even by the warships of a hostile power, and though France and England had been recently in arms against one another, and were on the verge of war, Captain Phillip received with every courtesy the members of the French expedition and its distinguished commander. It is possible the French might have had ulterior designs on Australia; they had recently lost Canada to Great Britain, and the dreams of an Indian Empire, so long indulged in by the Kings of France, was dissipated by the victories of Clive and his successors, and perhaps if Captain Phillip had not already been in possession the French might have claimed this portion of the continent as their own. However this may be, the territory was actually in the possession of the British, and La Perouse was fittingly entertained, and departed, unfortunately, to find an untimely end on the reefs of the New Hebrides. While in Botany Bay the French lost a very distinguished member, Father Le Receveur, chaplain of the expedition, and a man of distinguished scientific attainments. Father Le Receveur was a member of the Franciscan Order, a community which has a branch settled at Waverley, a Sydney suburb. The French buried their chaplain at La Perouse, and later on, when the government of King Charles X. dispatched an expedition to search for the missing navigator, that expedition visited Sydney and made a pilgrimage to the place, and, with the consent of the New South Wales government, erected the monument which commemorates the death of the chaplain and the visit of their distinguished countrymen to the shores of Botany Bay. The

fate of La Perouse and his companions long remained a mystery. Like the ill-fated Leichhardt, most contradictory stories were in circulation as to his ultimate end, and tales of his having visited various islands and parts separated by long stretches of ocean were current among mariners. It was not until 1826 that there was authentic information. In that year Captain Peter Dillon, who was visiting the island of Vanikoro in the New Hebrides, brought away with him relics which, after 28 years of uncertainty, forever set at rest any doubts that existed of the gallant explorer's fate. A large portion of the shores remain in their primeval condition, but it is anticipated that the opening of the tramway will facilitate not only the progress of settlement, but also the establishment of large manufacturing industries, especially as areas have been reserved, under the Working Men's Blocks Act, to enable the poorer classes of the community to remove from the more densely populated portions of Sydney to a healthier atmosphere, where their children may enjoy something of the freedom of open-air life under satisfactory conditions, and where the breadwinners will not be so far distant from their occupations that they may not readily be reached.

SELECTED FORMULÆ.

Chromium Glue for Wood, Paper, and Cloth.—The Pharmaceutical Era gives the following formula for chromium glue for wood, paper, and cloth.

(a) One-half pound strong glue (Irish glue if color is immaterial, white fish glue otherwise); soak 12 hours in 12 fluid ounces cold water. (b) One-quarter pound gelatine; soak 2 hours in 12 fluid ounces cold water. (c) Two ounces bichromate of potassium dissolved in 8 fluid ounces boiling water. Dissolve (a) after soaking, in a glue pot, and add (b). After (a) and (b) are mixed and dissolved, stir in (c). This glue is exceedingly strong, and if the article cemented be exposed to strong sunlight for one hour, the glue becomes perfectly waterproof. Of course, it is understood that the exposure to sunlight is to be made after the glue is thoroughly dry. The one objectionable feature to this cement is its color, which is a yellow-brown. By substituting chrome alum in place of the bichromate, an olive color is obtained.

The Following Perfume Formulæ from the Druggists Circular and Chemical Gazette may not be without interest and value:

Rose Sachet.

Rose petals	1,000 parts.
Sandalwood	600 parts.
Oil of rose	15 parts.

Violet Sachet.

Powdered orris root	500 parts.
Rice flour	250 parts.
Essence bouquet	10 parts.
Spring-flowers extract	10 parts.
Violet extract	20 parts.
Oil of bergamot	4 parts.
Oil of rose	2 parts.

Lavender Bouquet.

Oil of lavender	1½ ounces.
Oil of bergamot	1½ ounces.
Oil of lemon	1½ ounces.
Tincture of benzoin	½ ounce
Rose water	6 ounces.
Alcohol	3½ pints.

Patchouli Bouquet.

Oil of patchouli	½ drachm.
Oil of rhodium	15 drops.
Oil of rose geranium	30 drops.
Oil of citronella	20 drops.
Oil of orange	15 drops.
Oil of bergamot	1 drachm.
Oil of nutmeg	6 drops.
Oil of bitter almond	2 drops.
Oil of caraway	2 drops.
Benzoic acid	½ drachm.
Deodorized alcohol	18 ounces.

Starch Polish.—The Druggists Circular and Chemical Gazette gives the following formula for starch polish:

I.	Bleached carnauba wax	30 parts.
	Powdered French chalk	20 parts.
	White castile soap	12 parts.

Shave the soap and melt with the wax; stir in the chalk while cooling.

II.	Powdered borax	20 parts.
	Powdered starch	3 parts.
	Spermaceti	2 parts.
	Powdered white gum arabic	1 part.
III.	Powdered French chalk	15 parts.
	Powdered white soap	14 parts.
	Powdered borax	15 parts.
IV.	Powdered starch	30 parts.
	Powdered borax	15 parts
	Stearic acid	1 part.
	Alcohol, a sufficient quantity.	

Dissolve the stearic acid in alcohol, mix the solution with the starch, and leave exposed until the alcohol evaporates; then add the borax.

About a tablespoonful of any of the above mixtures is added to a pound of starch to produce the polish.

Black Ironwork Varnish.—The Pharmaceutical Era gives the following formula for black ironwork varnish:

Asphaltum, 48 pounds; fuse; add boiled oil, 10 gallons; red lead and litharge, of each, 7 pounds; dried and powdered copperas, 3 pounds; boil for two hours; then add dark gum amber (fused), 8 pounds; hot linseed oil, two gallons; boil for two hours longer, or till a little of the mass, when cooled, may be rolled into pills; then withdraw the heat, and afterward thin down with oil of turpentine, thirty gallons. Used for the iron-work of carriages.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

United States Trade With France.—The following extracts are from the annual report of Consul A. M. Thackara, of Havre, to be printed in full in Commercial Relations, 1902:

To form an idea of the many different varieties of American goods which are brought every week to Havre by the French Line, one has only to glance at the manifest of one of its steamers. The "Touraine," on one of its recent voyages, landed the following merchandise, nearly all of which was of American production, viz., dried apricots, dynamos and other electrical apparatus, typewriters, couplings, asbestos, silverware, household articles, photographic apparatus and materials, phonographs, oars, bicycles and parts, jewelry, refined oil, wheat, parquetry, cigar boxes, watch cases, watches, sausage cases, cocoa, coffee, picture frames, rubber, carbon, blacking, chairs, shoes, canned beef, canned soups, water meters, seashells, leather, electrotypes, ink, machine gears, cash registers, flour, steel and iron wire, insulated rubber wire, furs, air guns, grease, gilsonite graphite, lubricating oils, printed matter, toys, newspapers, linen ware, books, sewing machines, other machines (including shoemaking machinery), motors, novelties, tools, gold, sandpaper, paper, paper pulp, perfumery, patterns, shovels, dried prunes, chopped apples and pears, spices, pumps, wood pulleys, printing and other presses, hardware, medicinal roots, springs, emery wheels, water turbines, wheels, ribbons, lard, soap, saws, silk goods, tobacco, pictures, drums, vaseline, glassware, bladders, clothing, preserved meats, and whisky.

France is a larger importing nation than the United States. In 1901, the value of merchandise received in the former country was $910,000,000, against $823,000,000 imported into the United States. Of the French imports $603,000,000 were raw materials, $155,000,000 alimentary products, and $153,000,000 manufactured goods. Of the latter, the United States furnished only $18,000,000, or a little less than 12 per cent.

The trade of our country with France is handicapped to some extent by the heavier freights and custom duties our shippers have to pay, in comparison with their German and English competitors, and no doubt if the commercial agreement now existing between France and the United States were extended to cover other articles the trade between the two countries would be materially increased. The question arises whether, under the present conditions, more of our manufactured goods could not be exported to this country? My answer would be in the affirmative, considering the good quality, the low price, and the efficiency of American-made products. The methods which American manufacturers use in introducing their goods in France, however, do not compare favorably with those they employ in their own markets. My views upon the subject are embodied in a letter I recently wrote to one of our large commercial institutions, extracts from which follow.

What the future of our export trade will be when our exporters have reduced the exploitation of their goods abroad to an exact science, as our German and English competitors have done, would be hard to forecast. In my opinion, the outlook is rosy.

Take France as an example of a country in which there is a good field for an increase in our trade in manufactured goods. I speak of manufactured goods, for the exportation of our food products, cereals, and raw materials must continue to augment proportionately to the development of our natural resources, to supply the normal increase in demand. According to the official French customs statistics, the total imports into France in 1901 were valued at $910,000,000, of which the United States contributed $93,000,000—a fraction over 10 per cent. We sent to France 15 per cent of her wood imports, 20 per cent of the machines and machinery imported, 5.5 per cent of the tools and hardware, 11.8 per cent of the lumber and woodwork, 7 per cent of the dressed skins, 1.25 per cent of the chemical products, 18.75 per cent of the oil cake, and 7 per cent of the rubber goods received. The imports of paper pulp, jewelry, watches, clocks, pottery, and glassware from the United States were so comparatively small that they were included under the general terms of other articles. Now the question is whether the above percentage can be increased. I think it can.

I doubt very much if there are over fifty of our manufacturing concerns which are properly represented in France. I mean that there are not over the above number of American houses which have head agencies in Paris, with agents in the provincial cities who canvass their various districts to advertise their goods and to solicit orders.

Havre is a city of 130,000 inhabitants; but if one wished to buy American dairy machinery, he would not be able to do so without either going or writing to Paris. In that city, he would find the machines made by one or two American houses only, and sold by French concerns. On the other hand, in all the agricultural centers, French, Danish, and Swedish churns, centrifugal separators, butter workers, etc., are extensively advertised and kept in stock. There are few hotels, cafés, or restaurants in the farming districts of France in which posters are not displayed advertising American harvesting machinery and giving the name of the nearest resident agent. But I have never seen—and I have traveled over a large portion of France—an advertisement of a potato digger and sorter, or any of this class of labor-saving machines which are so extensively used in the United States.

American ice-cream freezers for family use can be bought in several of the department stores of Havre; but if you wanted a household refrigerator, the use of which is constantly increasing in France, you would find one store which keeps them, but only one make, and that not of the best. If you wanted an American base-burner stove, you might perhaps find one or two French imitations on sale; but to have the genuine article, if you happened to know the agents of American stoves in Paris (for they are not advertised), you could write and would receive a catalogue in reply, from which a selection could be made. If the stove chosen was in stock, you would receive it in about a week. If not on hand, you would have to wait at least six weeks.

Two of the best makes of American lawn mowers can be bought in Havre. American-made shoes are being more extensively displayed in the shop windows, but good assortments are by no means kept in stock. I have never seen American fire and burglar-proof safes on sale in this city, nor have I ever heard of one being used.

American lathes and other machine tools, made by several of our principal manufacturers, can be bought from the machinery dealers of Havre. If the tool desired should not be on hand, the dealer can easily get it from the agents in Paris, where large stocks are kept; but if a builder wished to introduce into a house the American system of heating by hot water or steam, or to furnish bath rooms with American specialties, he would find much trouble in doing so. Several of my friends have porcelain bath tubs and sanitary water-closets, but they sent to England for them.

American building hardware, locks, etc., are also but little known in the French provincial towns; neither are American sporting implements. In the past five years, outdoor sports have become very popular in France. Formerly, football and tennis were confined to Paris, where there is always a large colony of Americans and English, but now these games are extensively played in the provinces. I have never seen American balls, rackets, nets, etc., used. In my opinion, with proper methods our trade with France in the following products could be materially increased: Steam fire engines, printing presses, printing materials, hardware (including locks), builders' hardware, hot-air and gas engines; chairs, desks, and other office furniture; parlor organs, mechanical piano players, chemical products, etc.

Spasmodic attempts to create foreign trade are never successful. If our manufacturers really desire to secure outlets abroad for their products, they should make systematic efforts, based on sound business methods, to do so. They should become conversant with the needs and mode of life of the foreigners to whom they wish to sell their wares, and then furnish goods which will be acceptable. Let our exporters treat the foreigners courteously and kindly; let them feel that they can get what they want and that they can always depend upon quick and complete shipments of their orders. The principle that anything is good enough for foreigners will not increase our export trade. They know what goods they can sell, and the prices they can pay. Even more care and attention should be given to filling foreign orders than those for the home markets, for mistakes are harder to rectify. Do not send too much or too little, but execute the order exactly as it is given, or else vexatious delays are bound to occur, with possibly a refusal of the goods and a lawsuit, and certainly loss of future trade. One of the largest wood importers in France tells me that he is almost tempted to give up entirely the handling of American wood. He says he seldom receives a cargo which is according to order. Either the amount is in excess or it falls short, and often the quality is inferior to that which he expected to get. The American shipper, recognizing that the order is not properly filled, writes that the question of quantity and quality can be left to arbitration. This way of doing busines is always unsatisfactory to the buyer, as he never knows what he may expect, and there is an unforeseen expense.

Metric System.—The sooner American exporters learn the metric system of measurement, the better chance they will have of successfully meeting foreign competition in the French markets. For example: Austrian oak in France commands a higher price than American oak, and is used in preference, although in many cases the former is not as good as the American wood. The reason is that the Austrian shippers are careful in having their wood sawed to the metric dimensions called for by the French consumers, while the American shippers send their wood sawed to inches. There may not be much difference in the measurements, but there is enough to make the French cabinetmaker prefer the Austrian oak. The French customs law permits the free entry of certain woods if they are sawed to more than 2 decimeters (7.87 inches) square in the logs. If the logs measure even a small fraction under the above dimensions, they have to pay a duty of 1.50 francs (28.9 cents) per 100 kilograms (220.46 pounds). Frequently, owing to careless sawing and unfamiliarity with metric measurements, American shippers send logs to Havre which measure less than 7.87 inches, perhaps at one end only, which forces the consignee to pay the duty on the whole log.

At the present time, our country is enjoying wonderful prosperity. When the reaction takes place and there is a serious depression in our home markets, our manufacturers will realize that foreign trade is an important factor of our industrial life. Those who have kept up business relations with foreign consumers, and have outside outlets for the sale of their goods, will be the last to reduce their working force, to run on short time, or to sacrifice their overproduction by selling it at a loss on the home markets.

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TRADE NOTES AND RECIPES.

Dusting Powder for Infantile Eczema.—Starch, French chalk, lycopodium, of each, 40; bismuth subnitrate, 2; salicylic acid, 2; menthol, 1. Apply freely to the affected parts.—Rev. Med. Pharm.

Preservation of Books in the Tropics.—To prevent the destruction of books by tropical insects such as cockroaches and other pests which often do great damage, the covers, both inside and outside, should be painted over with the following mixture: Corrosive sublimate, 1 ounce; carbolic acid, 1 ounce; methylated or rum spirit, 2 pints. Books should be repainted with it every two or three years.—Agric. News.

Traumatol Gelatin.—The following application is prescribed by Gaudin for application to abscesses of the knee or other joints where a pliable dressing is required: Traumatol, gelatin, of each, 1; glycerin, distilled water, of each, 4. The mixture is heated on the water bath until fluid and homogeneous. The joint is first washed with soap and water, and dusted over with traumatol powder, then painted with the gelatin.—Deutsch. Amer. Apoth. Zeit.

To Copper Aluminium.—Take:

Sulphate of copper	30 parts
Cream of tartar	30 parts
Soda	25 parts
Water	1000 parts

It suffices to plunge the articles to be coppered in this bath, but they have to be well cleaned previously.

Or by means of a battery:

Phosphate of sodium	50 parts
Cyanide of potassium	50 parts
Cyanide of copper	50 parts
Distilled water	1000 parts

—Journal Suisse d'Horlogerie.

Liquid Brass Polish.—Oxalic acid, 3; water, 50; kieselguhr, 7. Dissolve the acid and add the earth. Label "Shake before using."—Neueste Erfind. und Erfahr., through Nat. Drug.

To Disguise the Taste of Bromipin.—Baucke recommends (Apoth. Zeit.) the use of a little peppermint oil added to the dose of bromipin mixed with warm milk, to cover the disagreeable taste of the drug.—Nat. Drug.

Cleansing Fluid for Grease Spots.—Oil of turpentine, 4; strong solution of ammonia, 4; spirit of soap (methylated), 2; acetic ether, 2; alcohol (methylated), 2. Mix. Label "Shake before using."—Chem. Zeit., through Nat. Drug.

Bay Rum.—Oil of myrcia acris, 33; sweet orange oil, 2.5; pimento oil, 2; alcohol (96 per cent), 2,000. Mix and allow to stand for twenty-four hours with frequent shaking. Then add water, 1,500, and magnesia, 25. Shake together at intervals for twelve hours, and filter.—Pharm. Post.

To Destroy Ants on Lawns.—J. B. Smith in "Economic Entomology" recommends the use of carbon disulphide to destroy ants' nests on lawns. A little of the disulphide is poured into the openings of the hill or disk, stepping on each as it is treated to close it up. The volatile vapors of the disulphide will penetrate the chambers of the nest in every direction, and if sufficient has been used will kill, not only the adult insects, but the larvæ as well. A single treatment is generally sufficient.—Agricult. News.

According to the Pharmaceutical Era, the manufacture of chewing gum is by no means the simple operation which it seems to be from an examination of the formulas. Much personal experience in manipulation is necessary to succeed, and the published formulas can at best serve as a guide rather than as something to be absolutely and blindly followed. Thus if the mass is either too hard or soft, change the proportions until it is right; often you will find that different purchases of the same article will vary in their characteristics when worked up. But given a basis, the manufacturer can flavor and alter to suit himself. The most successful manufacturers attribute their success to the employment of the most approved machinery and the greatest attention to details. The working formulas and the processes of these manufacturers are guarded as trade secrets, and aside from publishing general formulas, little information can be given.

Paraffin Chewing Gum.—Paraffin is dissolved at a gentle heat with a small quantity of sweet oil and glycerin, the amount of each depending upon the season—less being required in warm weather than in cold. The gum (Peruvian balsam, liquid amber, or whatever gum you desire to use) is then added and stirred in until the mass becomes homogeneous. Next add white sugar in powder, stir in, and finally add the flavoring extract (oil of wintergreen or any desired flavor). The mass is then poured out on a candy slab, rolled out into sheets, and cut into pieces of the desired size.

Chicle Chewing Gum.

1. Gum chicle	3½	pounds.
Paraffin wax	1	pound.
Balsam tolu	2	ounces.
Sugar	12	pounds.
Water	3	pints.
Flavoring		q. s.

By the aid of heat, dissolve the sugar in the water; pour the resultant syrup upon an oiled slab; add the chicle, paraffin wax and balsam tolu, all melted together, and mix thoroughly. This manipulation produces a tough, plastic mass, which, after incorporation of the desired flavoring—oil of peppermint, wintergreen or other flavor—may be cut into the proposed form.

2. Chicle	3¾	pounds.
White wax	1	pound.
Sugar	10	pounds.
Glucose	2	pounds.
Water	3	pints.
Balsam Peru	1	ounce.
Flavoring		q. s.

Prepare as in the preceding.

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